Leviat
A CRH COMPANY

Innovative Punching Shear Reinforcement

Fondazione
Ordine degli Ingegneri
Provincia di Roma

24 Marzo 2026

Imagine. Model. Make.

Content

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1. Introduction

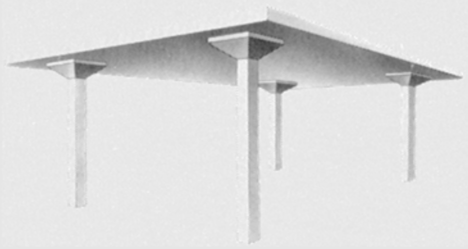
Different kind of slabs (history)

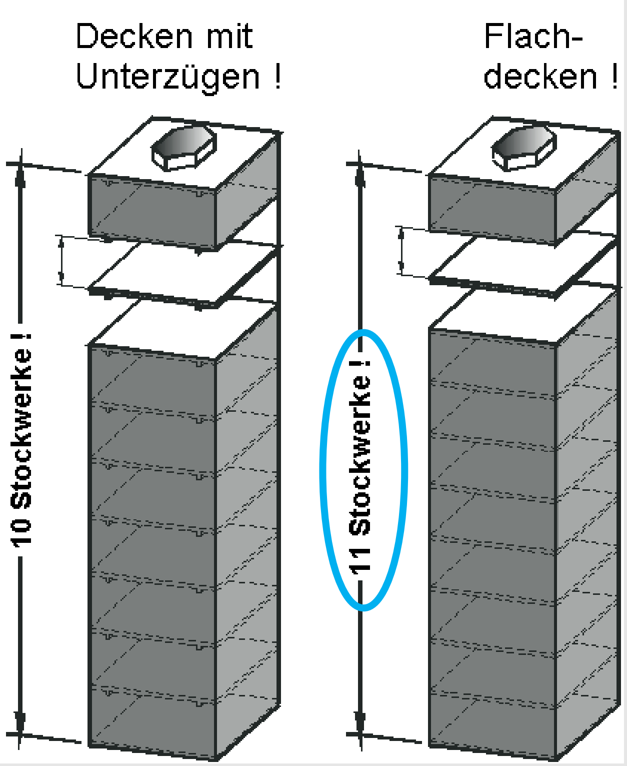
flat slab

rib and filler tile slab

slab with downstand beams

dropped panel slab





Advantages of flat slabs:

- reduced costs of shuttering
- Installation can be done easily
- to achieve a reduction in storey height

1. Introduction

Standard slabs with downstands blocks tube and pipe installation

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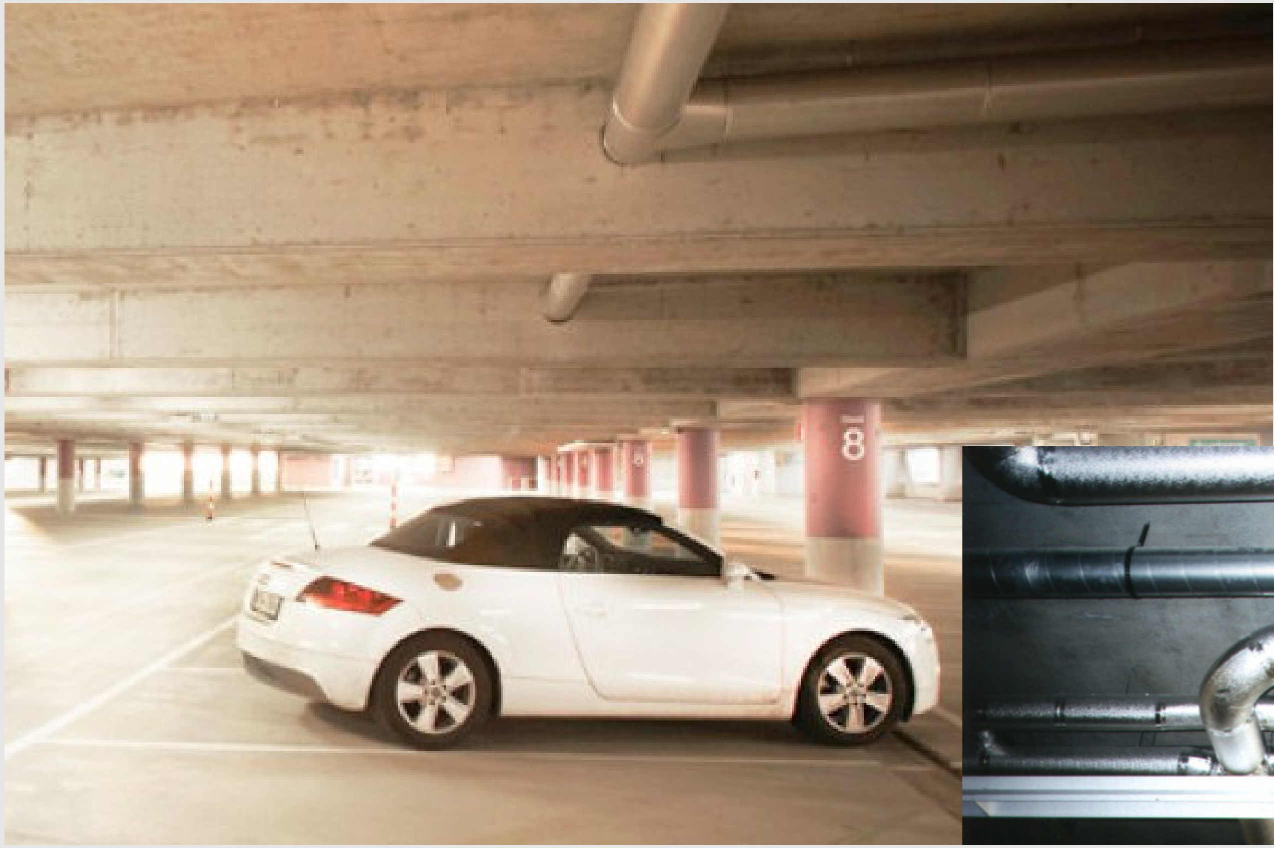
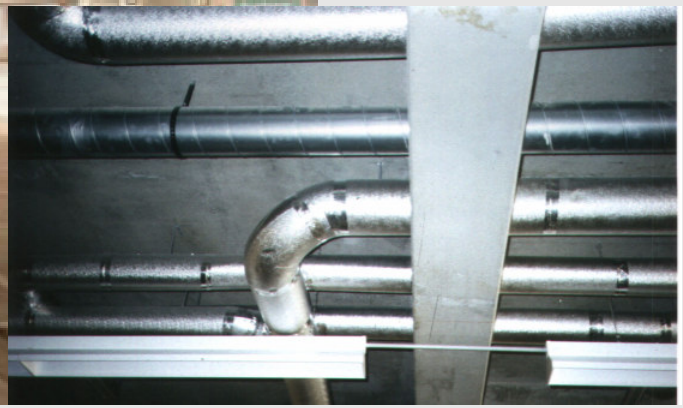
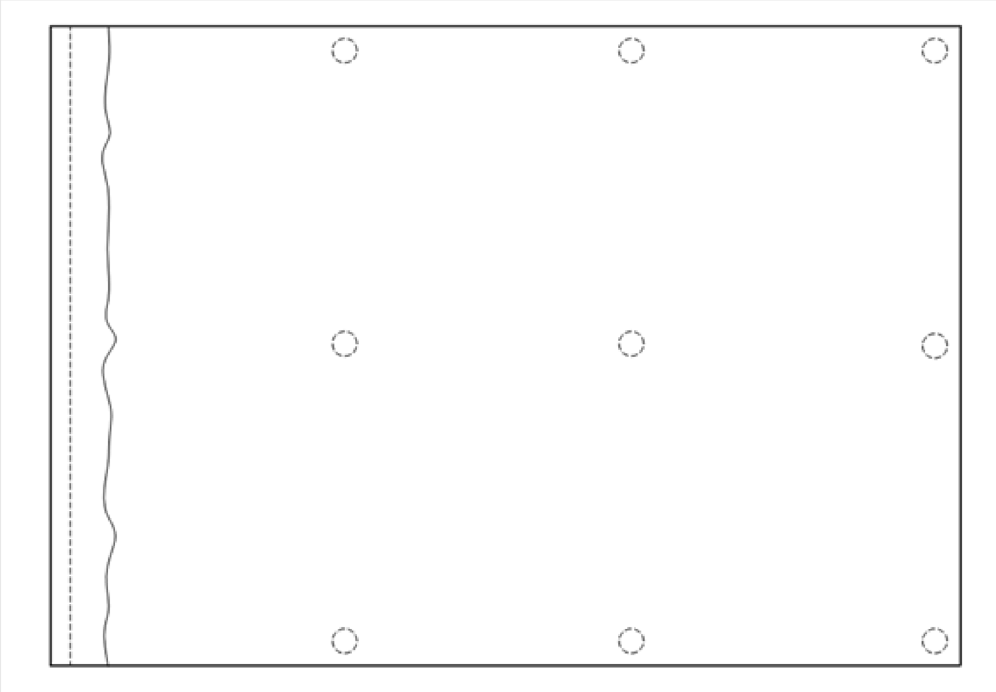


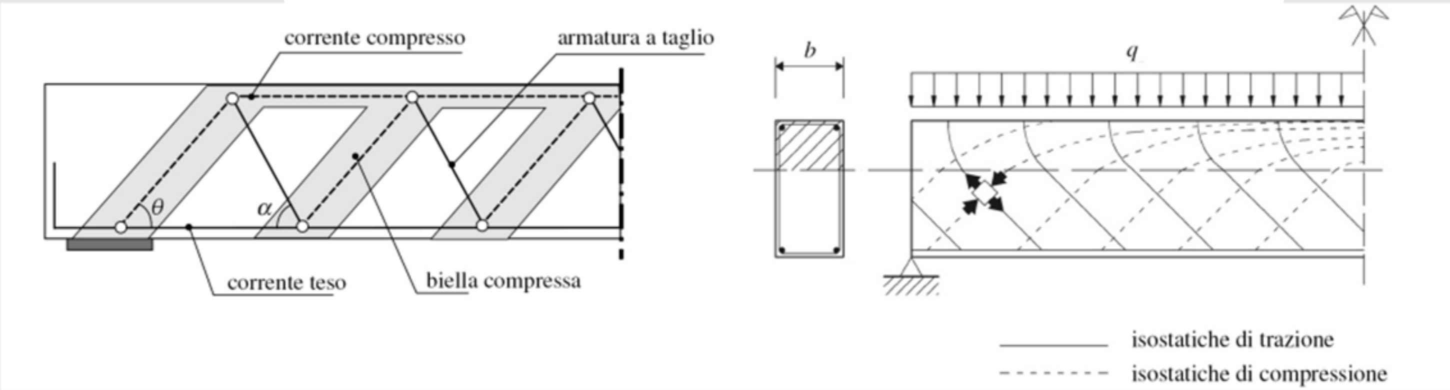


1. Introduction

Standard slabs without downstands

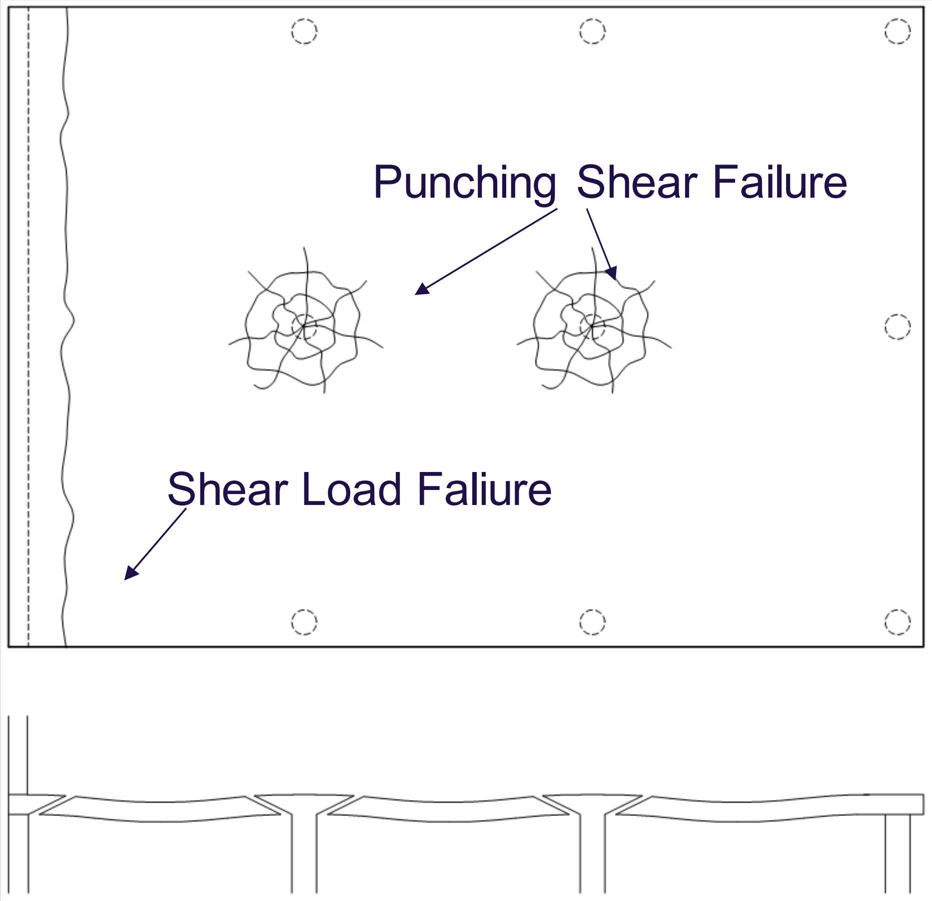
Basics



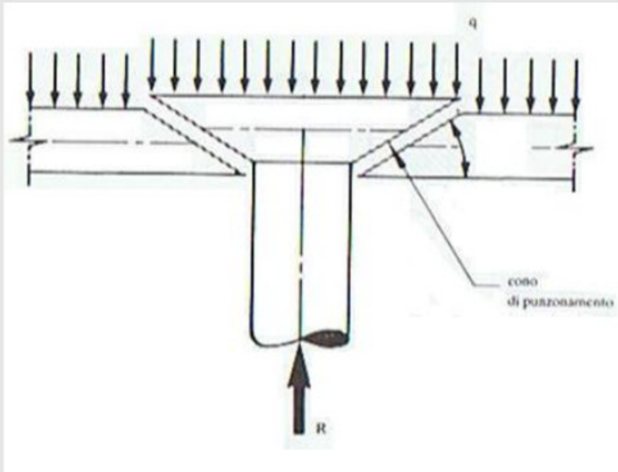


corrente compresso
armatura a taglio
θ
α
corrente teso
biella compressa
b
q
isostatiche di trazione
isostatiche di compressione

Basics



Punching Shear Failure
Shear Load Faliure



q
cono
di punzonamento
R

Punching shear failure example from site

Punching shear failure example from site

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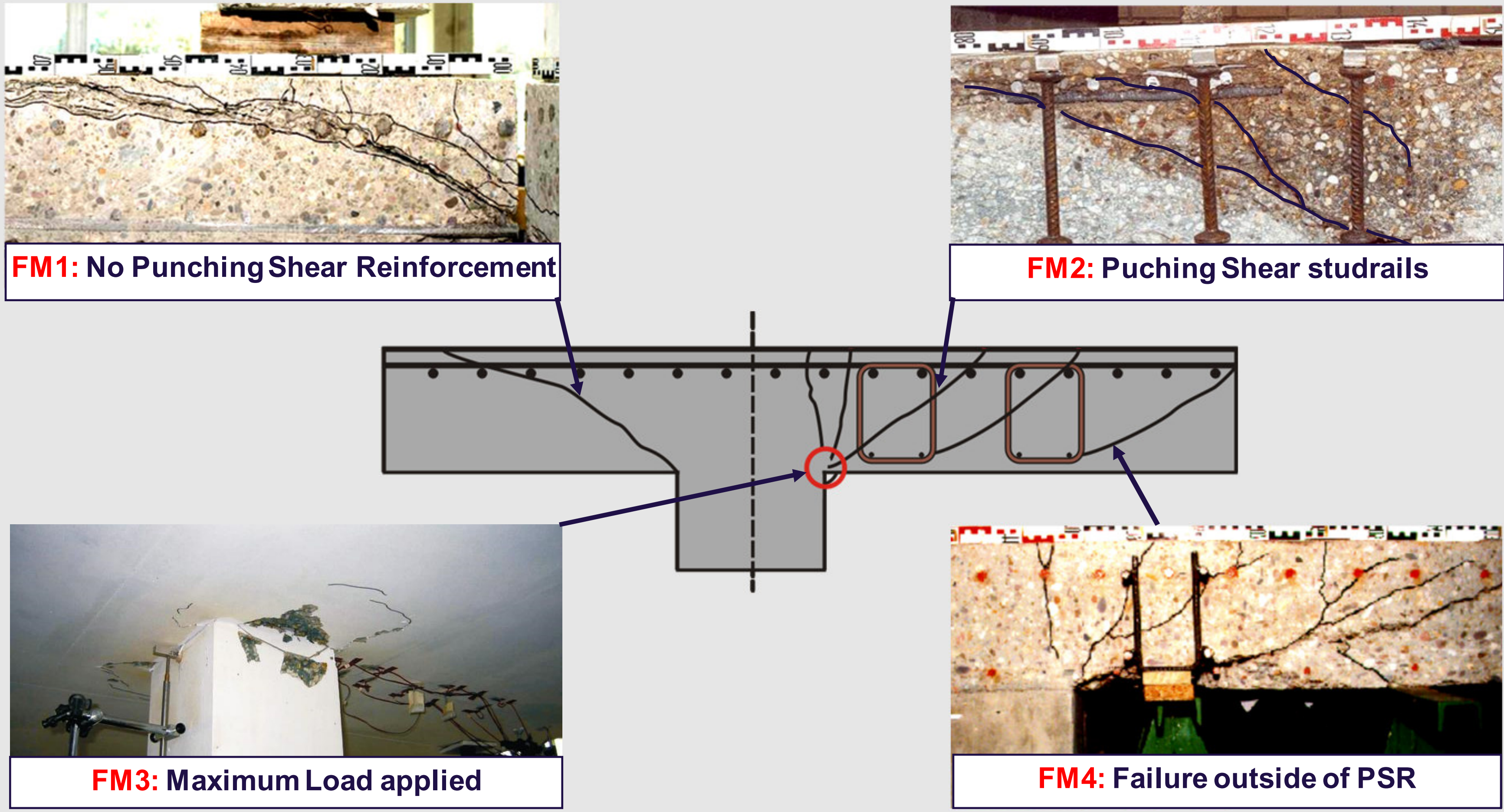
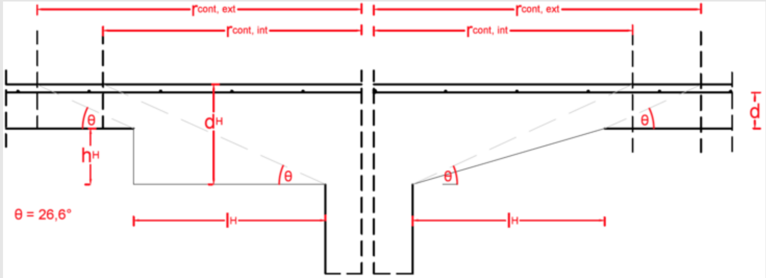
Introduction on punching shear reinforcement



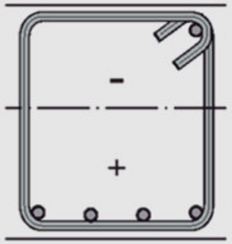
Punching Shear Reinforcement for Slabs

Concrete solution

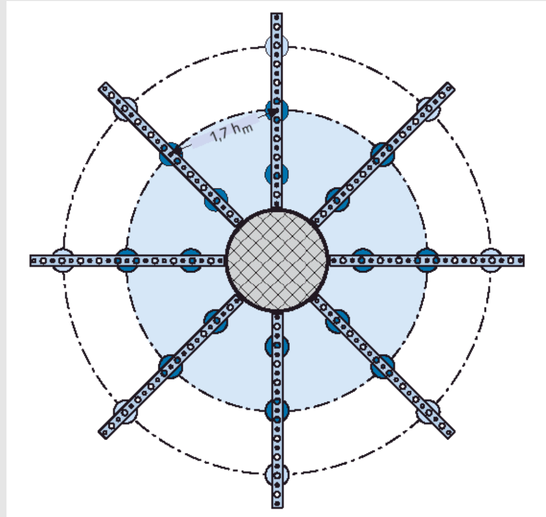


Steel solution

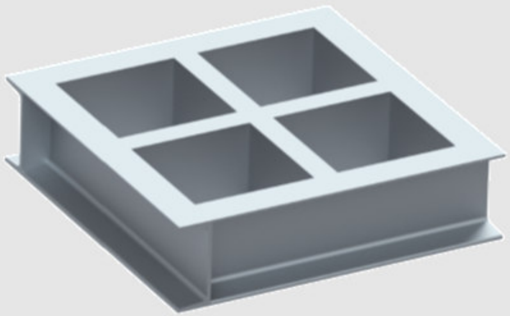
Stirrups

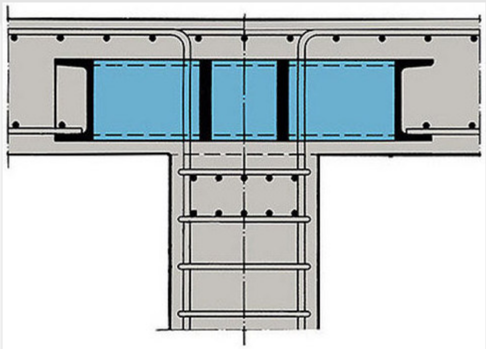


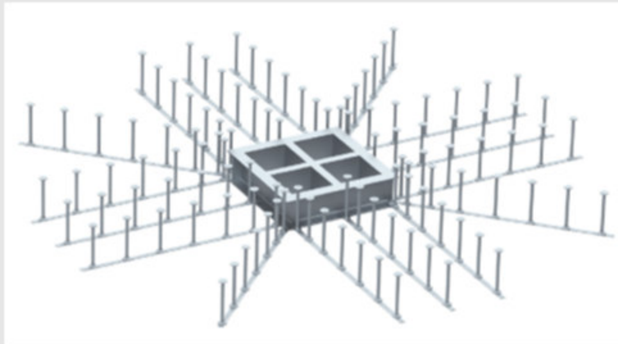
Double headed studs
Example: HDB Studrails



DURA Steelhead







Confronto prestazionale tra elementi a Punzonamento

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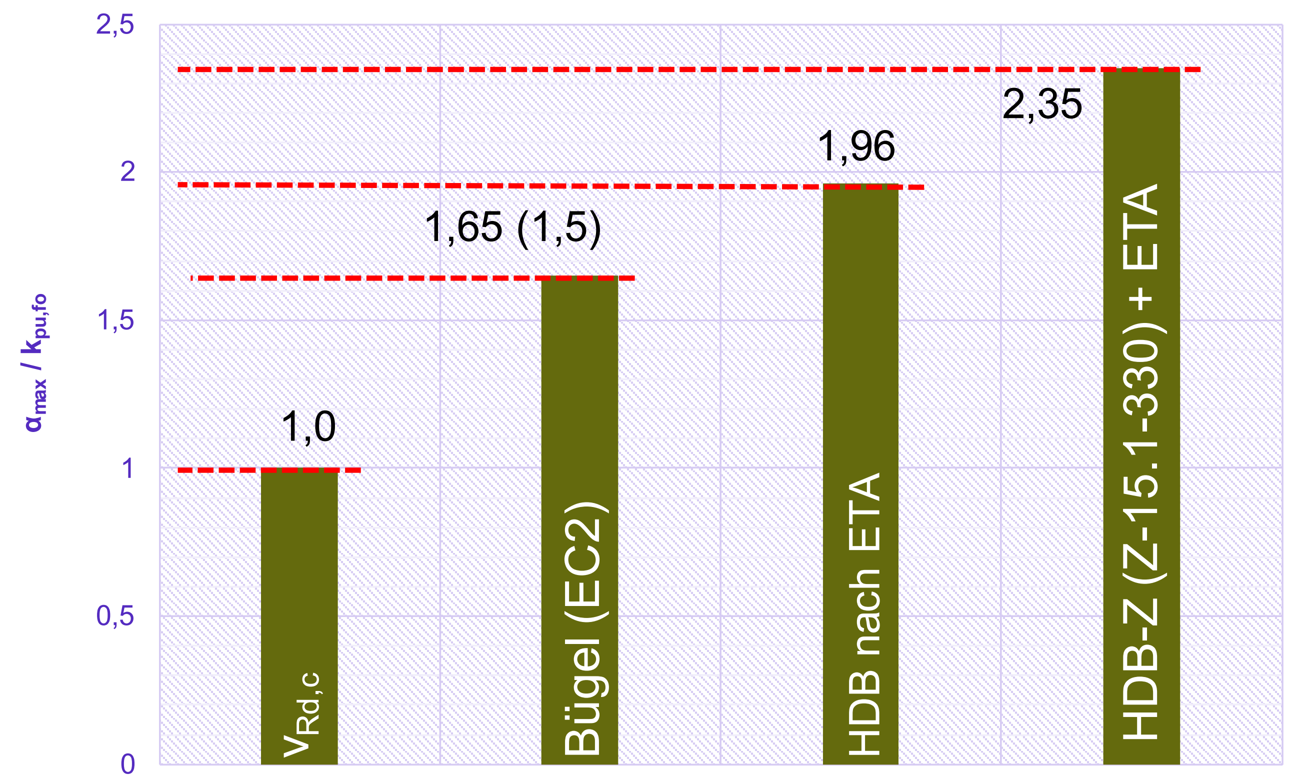
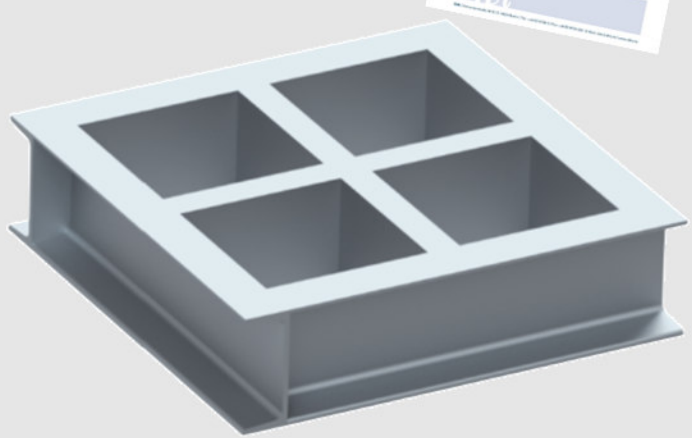
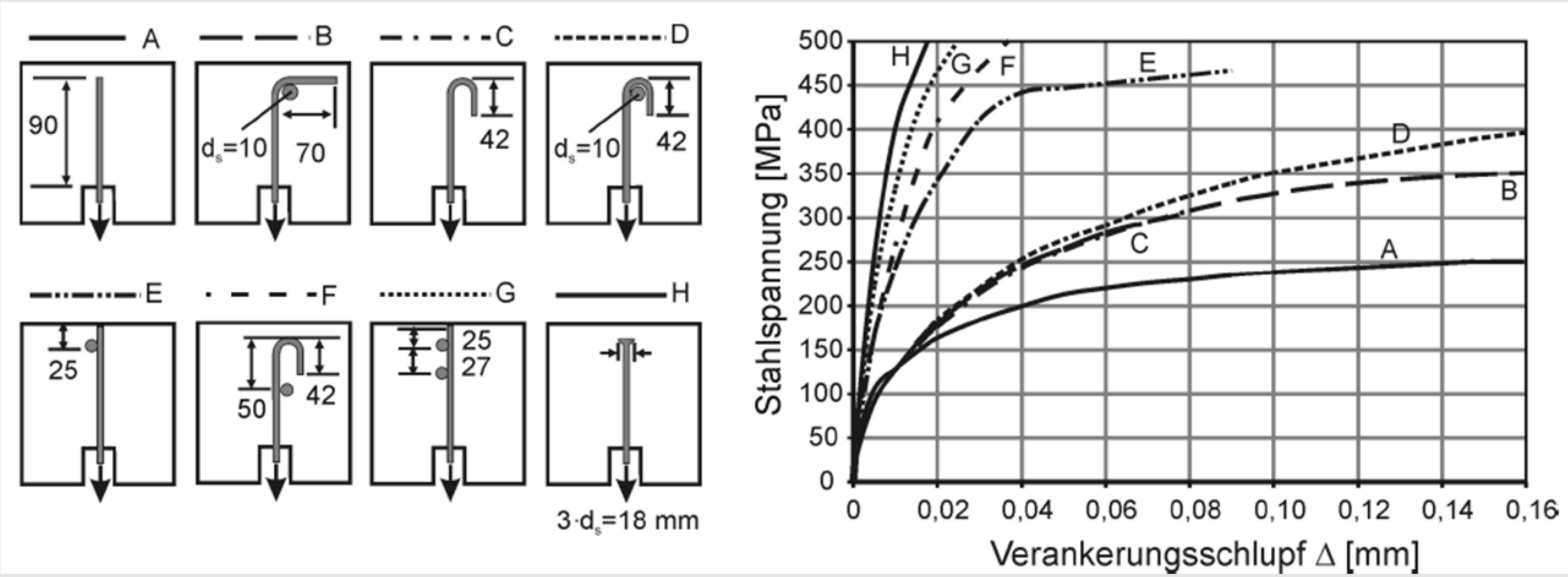
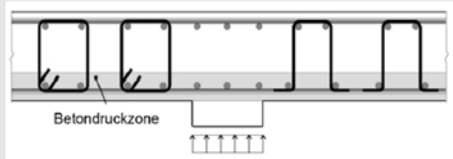


DURA Steelhead: Factor 3-5 depending on slab and column dimension







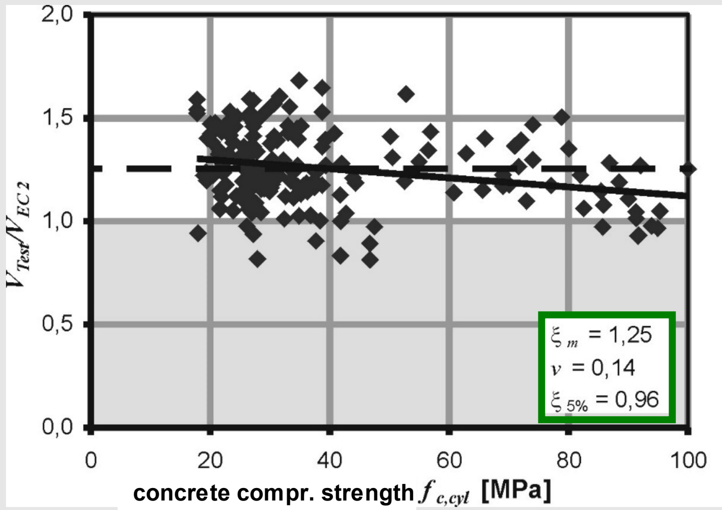
DOUBLE HEADED SYSTEMS ADVANTAGE:

- NERLY ZERO SLIP AT ULS➔ INCREASE MAX PUNCHING SHEAR LOAD CAPACITY
- USE FULLY YELD STRENGHT IN DESIGN INDIPENDETLY ON THE SLAB THICKNESS

Comparison

Load capacity without punching shear reinforcement

$$v_{Rd,c} = 0{,}12 \cdot k \cdot (100 \cdot \rho_l \cdot f_{ck})^{1/3} + 0{,}10 \cdot \sigma_{cp}$$



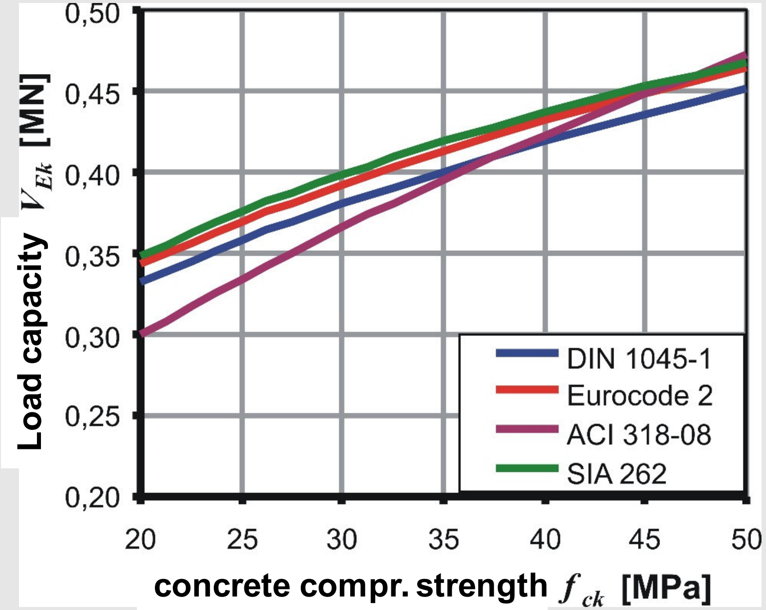
Database di n° 188 test
V_{EC2} considera coefficienti parziali di sicurezza =1

(Hegger et al. 2008)

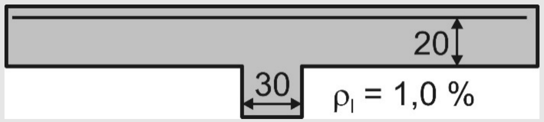
Safety level is sufficient ($\xi_{5\%}$ ~ 1,0) !

Comparison

Load capacity without punching shear reinforcement



- Minor differences in load bearing capacities
- Mainly similar influencing factors
- Database ~ 200 tests



Comparison

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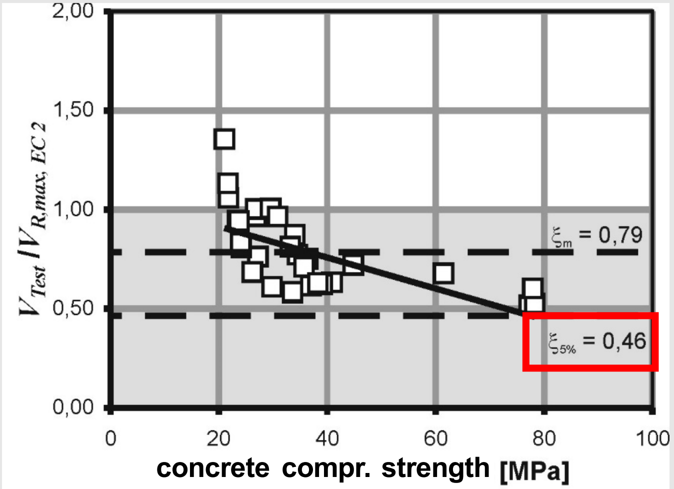
Maximum punching shear capacity

$$v_{Rd,\max} = 0{,}5 \cdot 0{,}6 \cdot \left(1 - f_{ck}/250\right) \cdot f_{cd}$$



Vrd,max dipende linearmente da fck
Vrd,max non dipende dalla % di armatura a flessione

Eurocode 2 does not achieve the required safety level!

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4. Structural calculations

Design according to ETA

4. Structural calculations

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Structural calculation principles

- structural design

$$S_d < R_d$$

- S_d – sum of actions
- R_d – resistance to forces

4. Structural calculations

Structural calculation principles

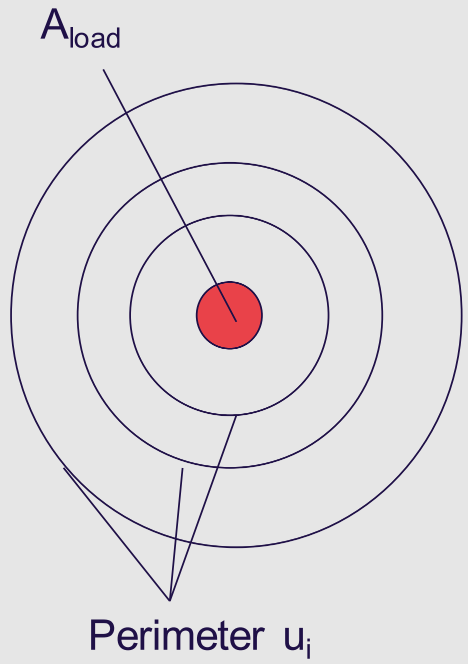
- Consideration of perimeter

  The design resistance of defined perimeters is to be calculated.

V_{Ed} – load of slab on loaded area A_{load}

- Formula for circular sections:

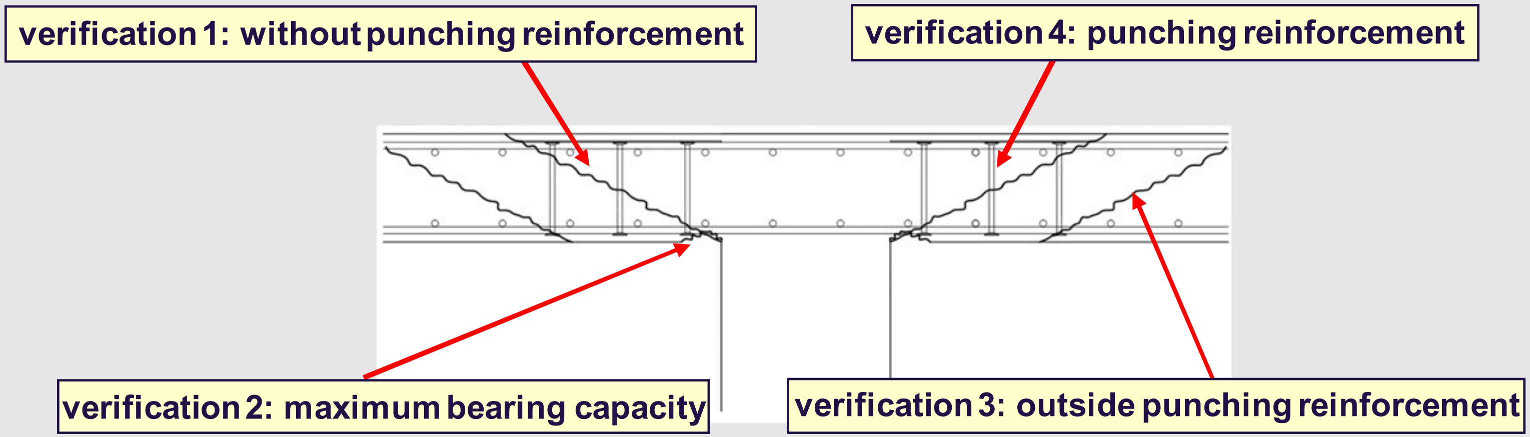
$$V_{Rd} = v_{Rd}\,(\rho, f_{ck}) \cdot u_i \cdot d \geq V_{Ed} \cdot \beta$$



ß = factor for increased load

4. Structural calculations

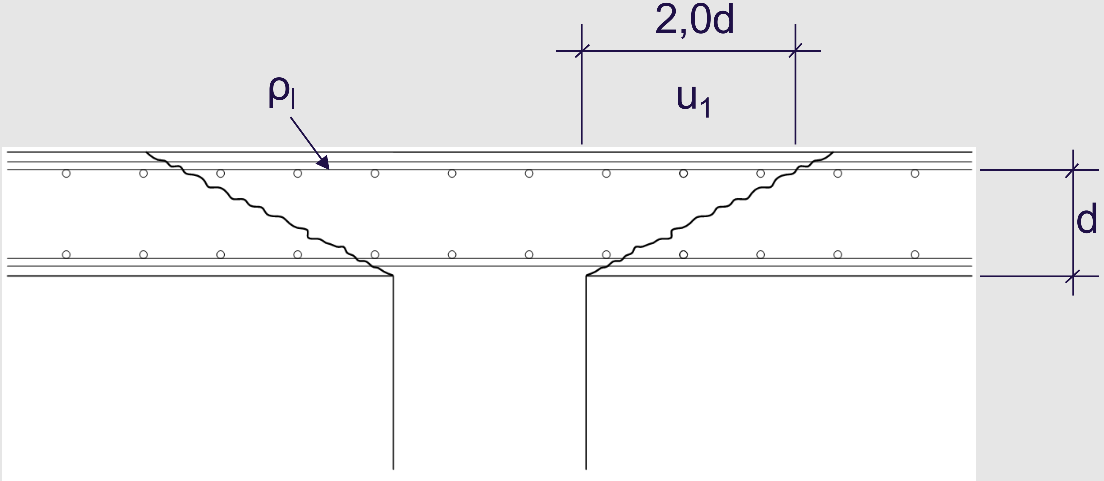
Failure Mode → Design Concept HDB



4. Structural calculations

Verification 1:

Is punching reinforcement required or not?



EN 1992-1-1, 6.4.4, 6.47 / ETA-12/0454 (A3):

$v_{Rd,c} = C_{Rd,c} \cdot k \cdot (100 \cdot \rho_l \cdot f_{ck})^{1/3} (+ k_1 \cdot \delta_{cp})$

$\mathbf{V_{Rd,c} = v_{Rd,c} \cdot u_1 \cdot d \leq V_{Ed} \cdot \beta}$

Si adottano i valori raccomandati
$C_{Rd,c} = 0{,}18/\gamma_c$,

4. Structural calculations

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Verification 1:

Is punching reinforcement required or not?

EN 1992-1-1, 6.4.4, 6.47 / ETA-12/0454 (A3):

$v_{Rd,c} = C_{Rd,c} \cdot k \cdot (100 \cdot \rho_l \cdot f_{ck})^{1/3} (+ k_1 \cdot \delta_{cp})$

$\mathbf{V_{Rd,c} = v_{Rd,c} \cdot u_1 \cdot d \leq V_{Ed} \cdot \beta}$

Verification: $v_{Ed} \leq v_{Rd,c} \Rightarrow$ no punching shear reinforcement necessary

$v_{Ed} > v_{Rd,c} \Rightarrow$ punching shear reinforcement necessary

Recommended values ETA-12/0454:

$C_{Rd,c} = 0{,}18 / \gamma_s = 0{,}18 / 1{,}5 = 0{,}12$

$C_{Rd,c} = \frac{0{,}18}{\gamma_s} \cdot \left(0{,}1\frac{u_0}{d} + 0{,}6\right) \geq \frac{0{,}15}{\gamma_s} = 0{,}10$,if $u_0 / d < 4{,}0$

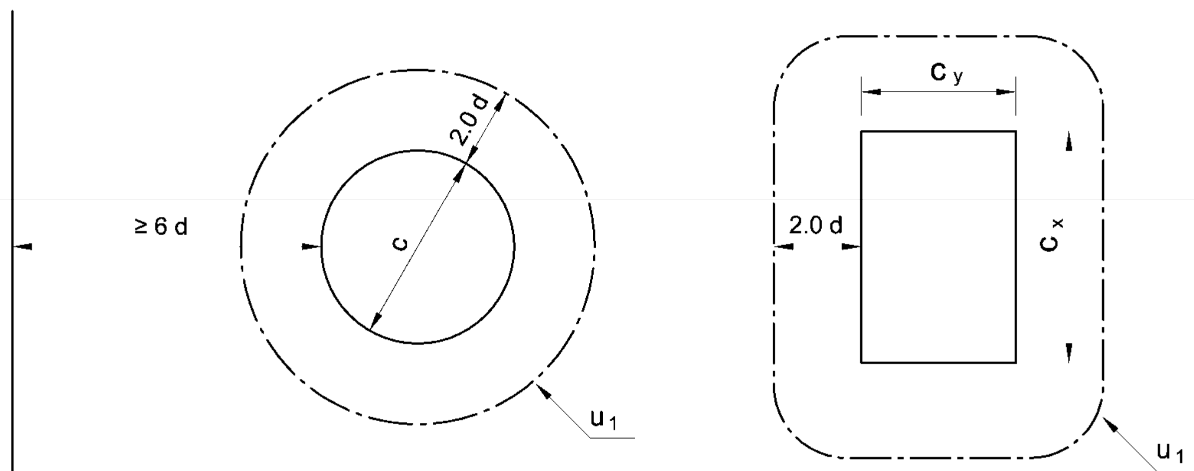
$\rho_l = (\rho_{lz} \cdot \rho_{ly})^{½} \leq 2{,}0$ and $\leq 0{,}5 \cdot f_{cd} / f_{yd}$

k = 1+ (200/d)^0,5

4. Structural calculations

Critical Perimeter – Internal Column

Loaded area (columns) is more than 6 d from openings or slab free edges

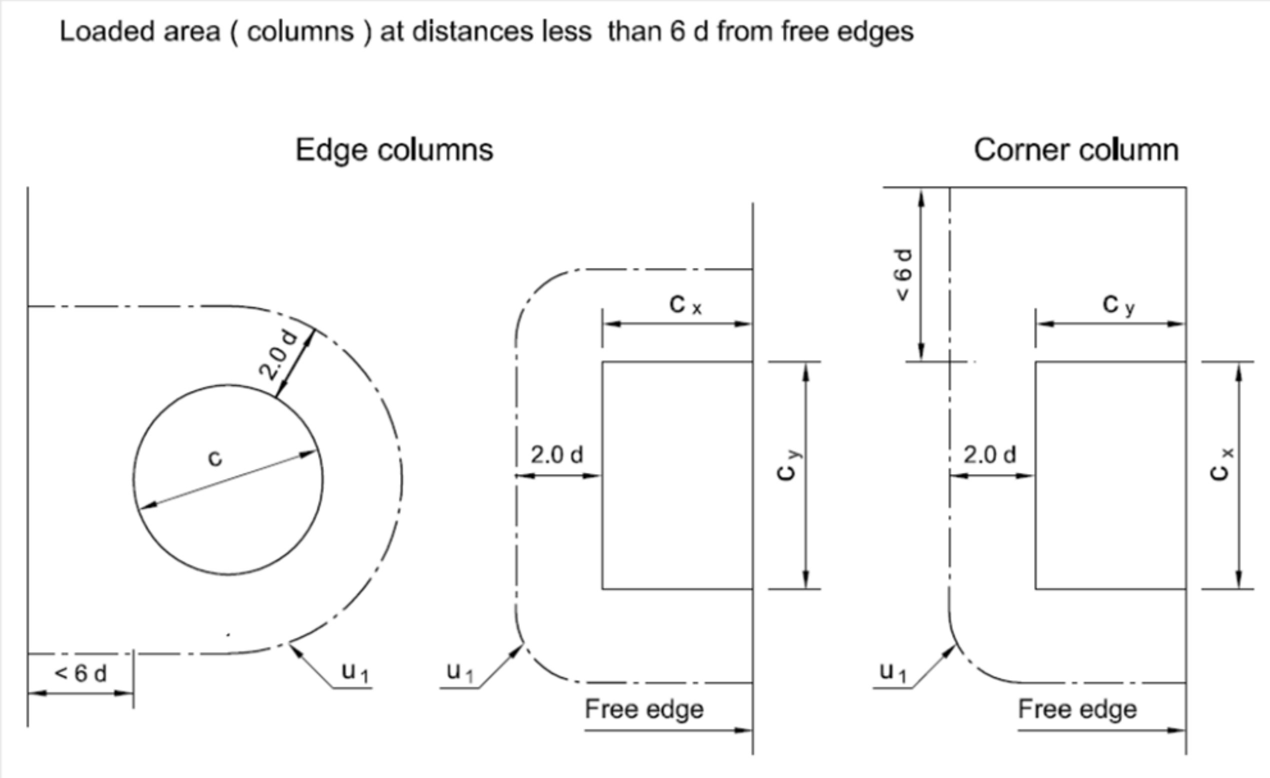


$u_1 = \pi \times (c + 4d)$

$u_1 = 2 \times (c_x + c_y) + 4d \times \pi$

4. Structural calculations

Critical Perimeter – Edge Column / Corner Column



4. Structural calculations

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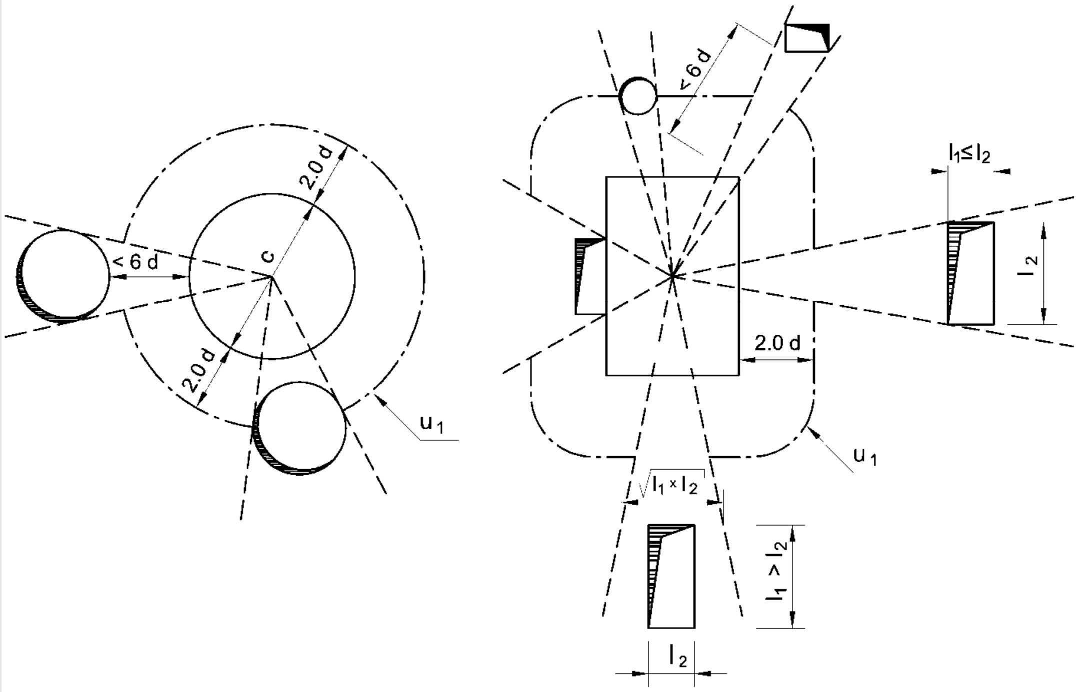
Critical Perimeter – Openings

Load area (columns) is less than 6d from openings (voids) in the slab



4. Structural calculations

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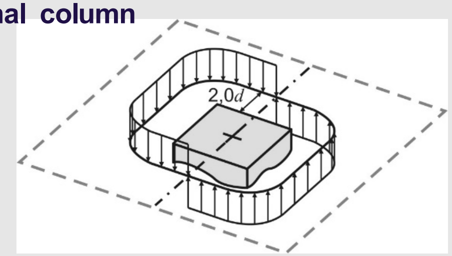
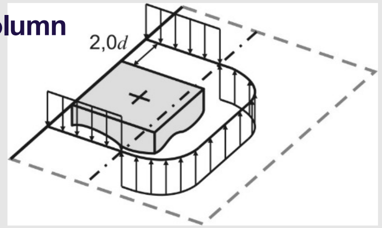
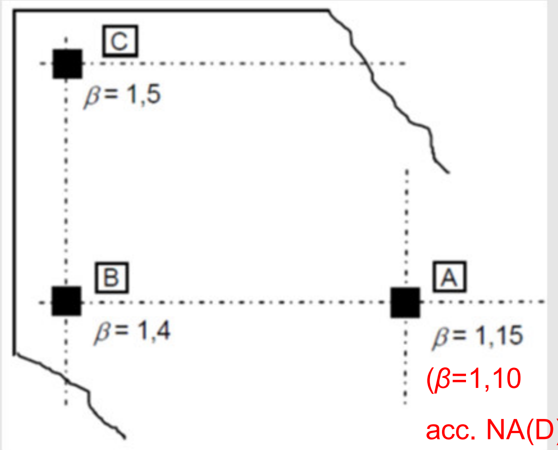
Load Increase Factor β - general

internal column



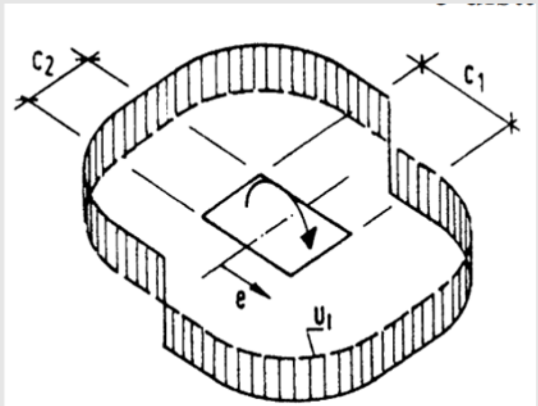
edge column





(β=1,10 acc. NA(D))

The more precise method of assuming plastic shear distribution than with EN 1992-1-1:2011-01 can be used as an alternative or as soon as the span width of adjoining slabs deviate more than 25 % from each another.



$$\beta_{EC2} = 1 + k \cdot \frac{M_{Ed,Sl} \cdot u_1}{V_{Ed} \cdot W_1}$$

plastic shear spread

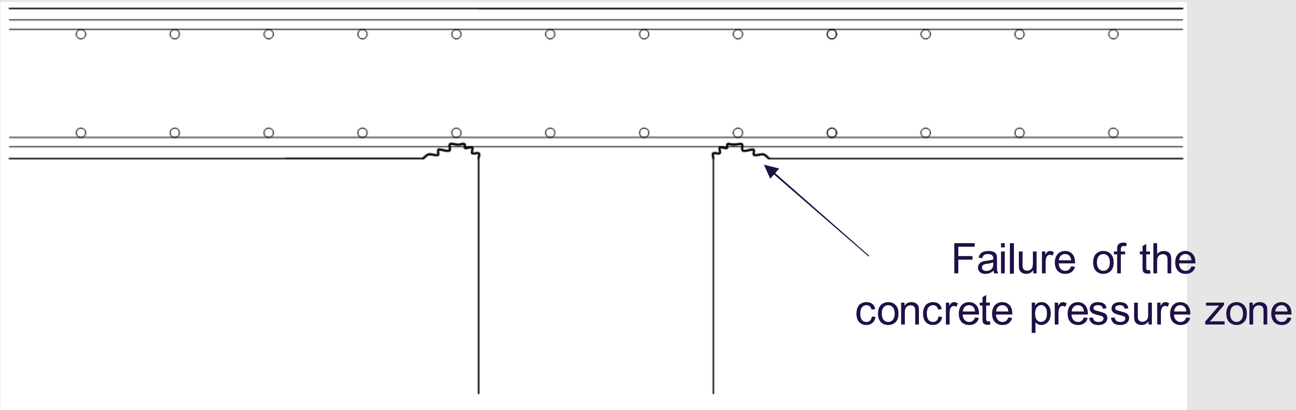
recommended values

$$W_1 = c_1^2/2 + c_1 c_2 + 4c_2 d + 16d^2 + 2\pi d c_1$$

4. Structural calculations

Verification 2

Is the maximum resistance sufficient?



ETA-12/0454 (A8):

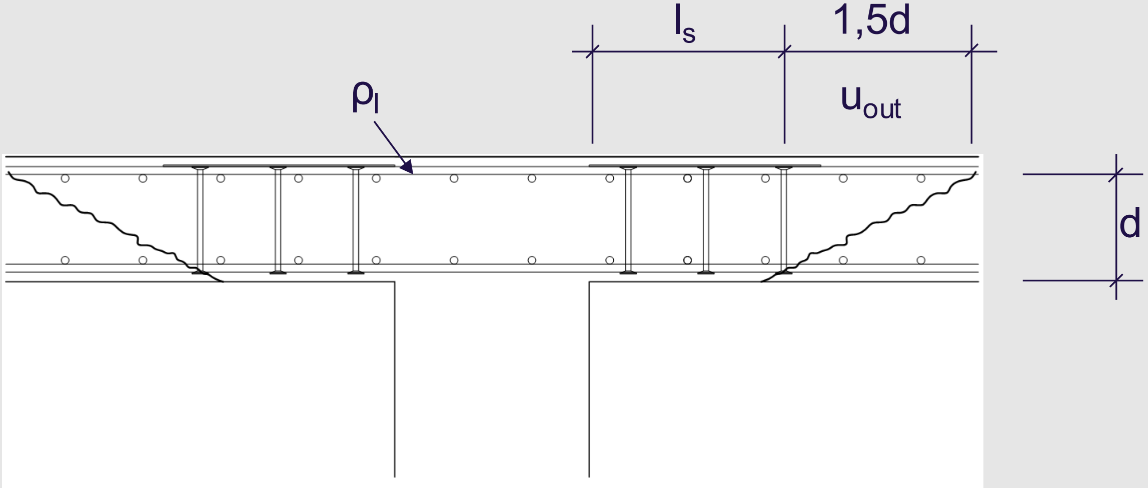
$V_{Rd,max} = 1{,}96 \cdot V_{Rd,c} \leq V_{Ed} \cdot \beta$

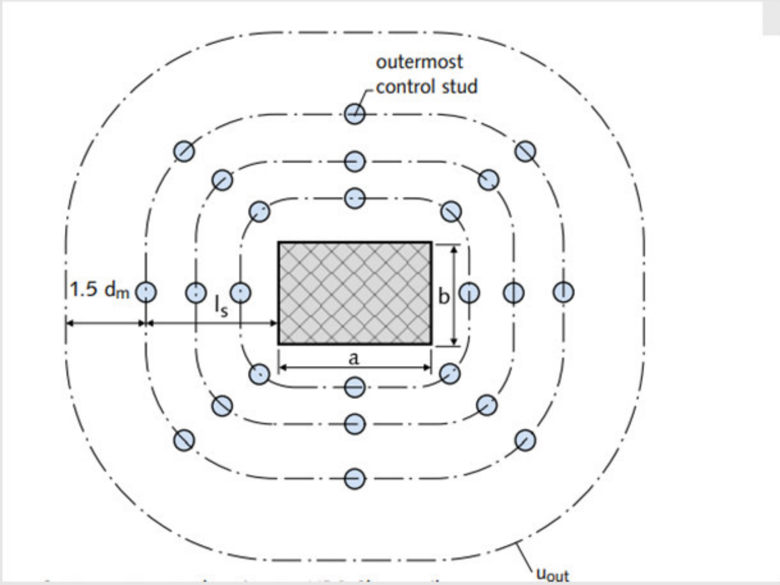
$\mathbf{1{,}0 \cdot V_{Rd,c} < V_{Ed} \cdot \beta \leq 1{,}96 \cdot V_{Rd,c} = V_{Rd,max}}$

4. Structural calculations

Verification 3

Where is the last stud?





<u>EN 1992-1-1, 6.4.4, 6.54 / ETA-12/0454 (A4):</u>

$v_{Rd,c} = C_{Rd,c} \cdot k \cdot (100 \cdot \rho_l \cdot f_{ck})^{1/3} (+ k_1 \cdot \delta_{cp})$

$\mathbf{V_{Rd,out} = v_{Rd,c} \cdot u_{out} \cdot d \leq V_{Ed} \cdot \beta_{red}}$

4. Structural calculations

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Verification 3:

Where is the last stud placed?

EN 1992-1-1, 6.4.4, 6.54 / ETA-12/0454 (A4):

$v_{Rd,c} = C_{Rd,c} \cdot k \cdot (100 \cdot \rho_l \cdot f_{ck})^{1/3} \; (+\, k_1 \cdot \delta_{cp})$

$\mathbf{V_{Rd,out} = v_{Rd,c} \cdot u_{out} \cdot d \leq V_{Ed} \cdot \beta_{red}}$

Recommended values ETA-12/0454:

$C_{Rd,c} = 0{,}15 \,/\, \gamma_s = 0{,}15 \,/\, 1{,}5 = 0{,}10$

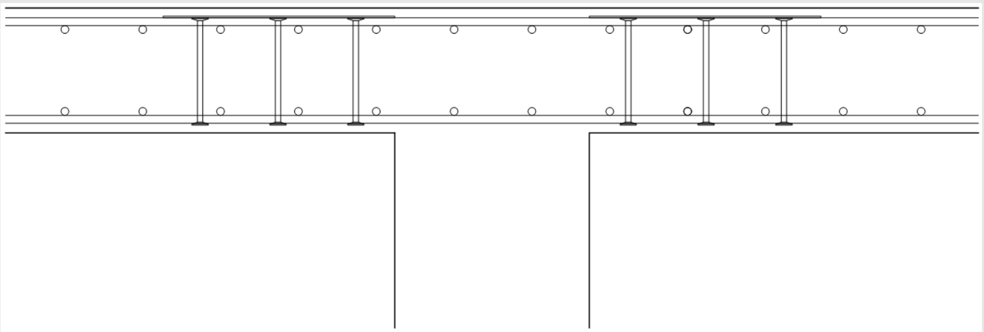
$\beta_{red} = 1{,}0 \cdot \beta \;\geq 1{,}10$

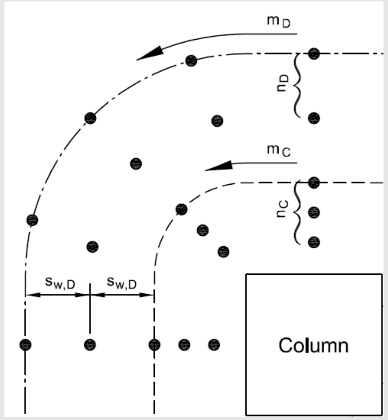
$\beta_{red,edge\ column} = \dfrac{\beta}{1{,}2 + \beta/20 \cdot l_s/d} \geq 1{,}10; \quad \beta_{red,corner\ column} = \dfrac{\beta}{1{,}2 + \beta/15 \cdot l_s/d} \geq 1{,}10$

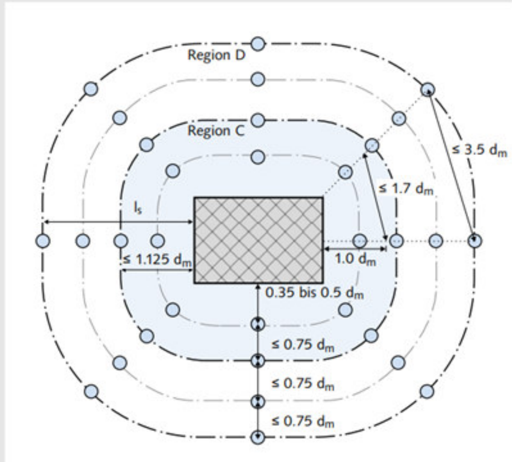
4. Structural calculations

Verification 4

Design of the stud diameter.







ETA-12/0454 (A7):

$$V_{Rd,sy} = m_c \cdot n_c \cdot A_A \cdot f_{yd} / \eta \leq V_{Ed} \cdot \beta$$

$$\eta = \begin{cases} 1{,}0 \text{ if } d \leq 200\text{mm} \\ 1{,}6 \text{ if } d \geq 800\text{mm} \end{cases}$$

4. Structural calculations

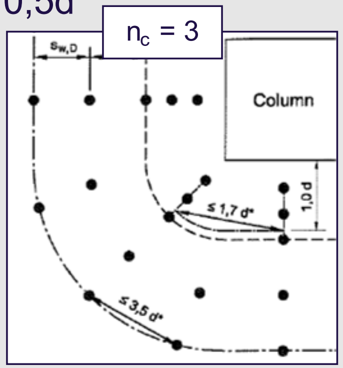
HDB – Arrangement – Flat Slab

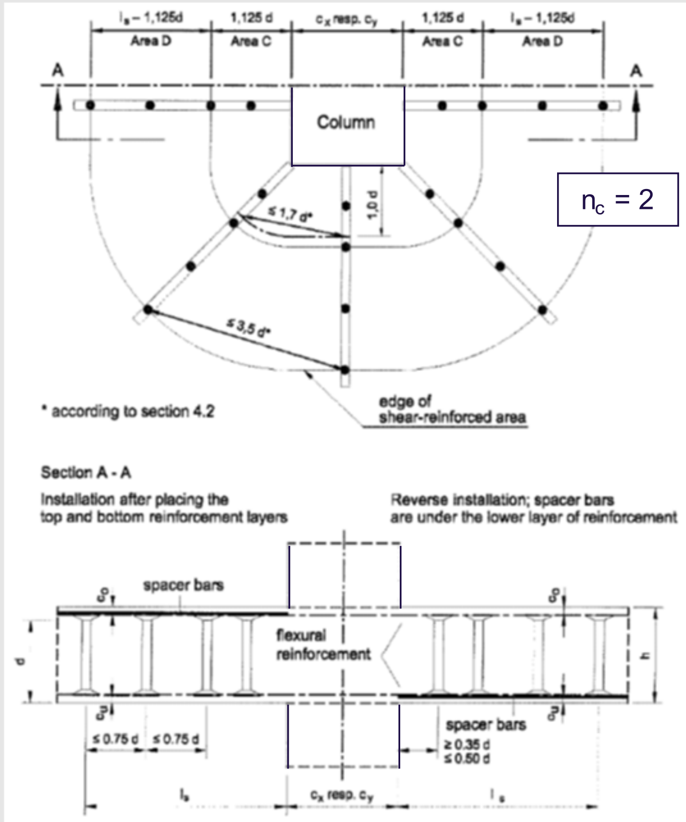
constructive rules in area C:

- min. 2 studs per rail
- Distance between first stud and column = 0,35d - 0,5d
- Distance between following stud ≤ 0,75d
- Tangential distance between studs at a distance of 1,0d to the column ≤ 1,7d

constructive rules in area D:

- Radial distance between studs ≤ 0,75d
- Tangential distance between studs on the edge of area D ≤ 3,5d





WHITE PAPER – NOVEMBER 2025

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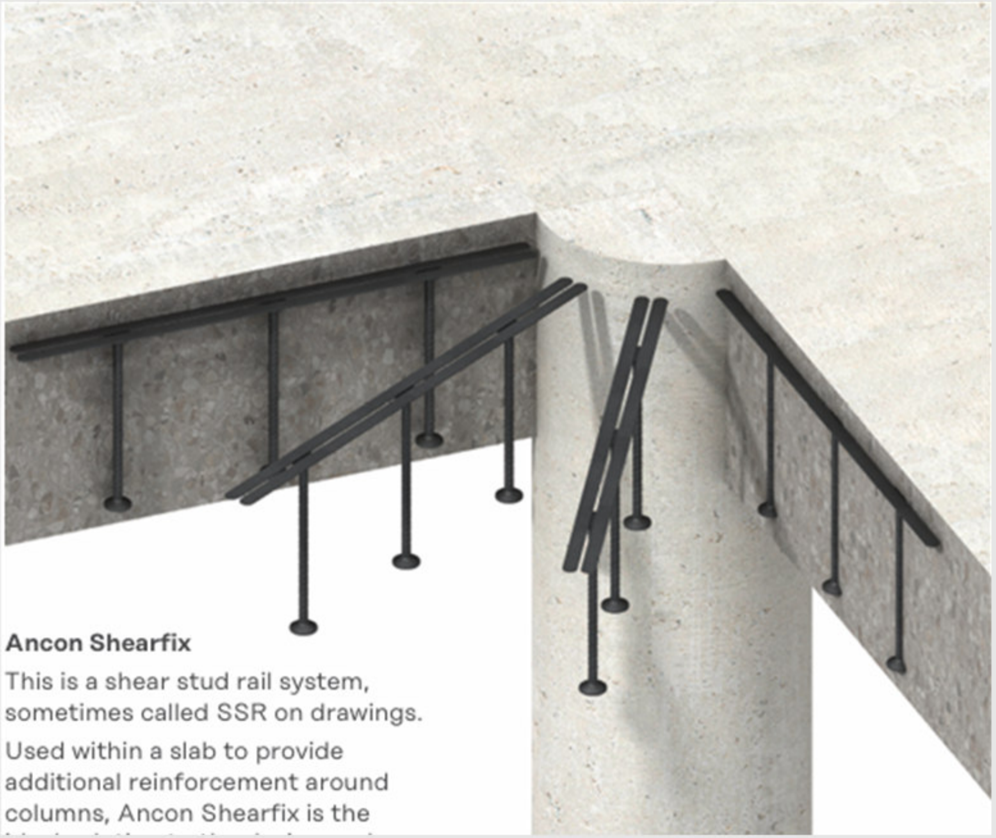

Considerations for
Building Safer Structures with Proven Punching Shear Solutions

White paper, November 2025

Sampoong Department Store, Seul (1995)

The Sampoong Department Store collapse remains one of the most tragic structural failures in modern history.[5]

Charles de Gaulle Airport Terminal 2°, Paris (2004)

Champlain Tower Shouth, Florida (2021)

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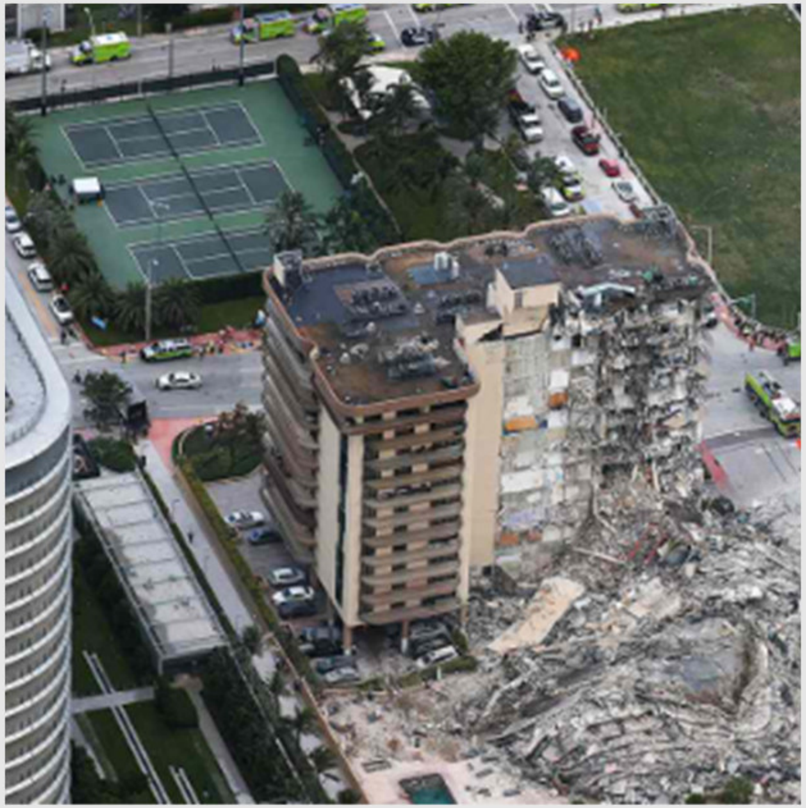

Comparison in major global standards

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Aspect	Eurocode 2 Gen 1	Eurocode 2 Gen 2	EOTA TR 065 (for ETA)	ACI 318	AS 3600	SIA 262
Distance to control perimeter	2d	0.5d	2d	0.5d	0.5d	0.5d
Inclusion of headed stud punching shear reinforcement	✗ (covered by CARES or ETA certification)	✓	✓	✓	✗ (relevant rules adopted from 'Lim & Rangan' research)	✓
Concentration of punching shear stresses at the corner of columns: long "blade" columns and large columns	✗ (included in current Ancon Shearfix software as "best practice" option)	✓	✗	✓	✓ long "blade" columns ✗ large column dimensions	✓
Factor accounting for eccentric shear	The design punching shear stress is increased by the factor β. $v_{Ed} = \beta \frac{V_{Ed}}{u_i d}$ $\beta = 1 + k \frac{M_{Ed}}{V_{Ed}} \frac{u_1}{W_1}$	The design punching shear stress is increased by the factor β_e $\tau_{Ed} = \beta_e \frac{V_{Ed}}{b_{0.5} d_v}$ $\beta_e = 1 + 1.1 \frac{e_b}{b_b}$	Refers to EC2 Gen 1 β factor. Introduces iterative calculation of β_{red} for outer perimeters.	The design punching shear stress is the sum of a shear component and a portion of the unbalanced moment. $V_u = \frac{V_u}{A_c} + \frac{\gamma_v M_u c}{J_c}$	Unbalanced moments are transferred to the side faces of the column through torsion. $V_u = \frac{V_{uo}}{1 + uM^*_v/(8V^*ad_{om})}$	The length of the control perimeter is reduced by the factor k_e (inverse of EC2 approach). $V_d = \frac{V_d}{k_e u}$ $k_e = \frac{1}{1 + \frac{e}{b}}$
Distance to first stud	≥ 0.3d; ≤ 0.5d	≥ 0.3d; ≤ 0.5d	≥ 0.35d; ≤ 0.5d	≥ 0.35d; ≤ 0.5d	≤ 0.5 x tangential stud spacing	≥ 0.3d; ≤ 0.75d
Maximum tangential stud spacing	1.5d: within 2d of column face 2d: beyond 2d of column face.	1st perimeter, $s_{t,max}$ = 0.75d ≤2d from column face, $s_{t,max}$ = 1.5d >2d from column face, $s_{t,max}$ = 3d	1.7d: within 1d of column face 3.5d: beyond 1d of column face.	2d	Lim & Rangan: min. 2 stud rails per column face.	0.75d

Key Changes relevant to punching shear

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Point of contraflexure factor

A new provision increases calculated punching shear resistance where the change of slab bending moment direction is close to the column location. This is particularly relevant to advanced slab modelling. [22]

> 8.4.3 (2) For distances between the centre of the support area and the point of contraflexure in the considered load combination a_p smaller than $8d_v$, the value of d_v in Formula (8.94) may be replaced by:
>
> $$a_{pd} = \sqrt{\frac{a_p}{8} \cdot d_v} \qquad (8.97)$$
>
> where
>
> $$a_p = \sqrt{a_{p,x} \cdot a_{p,y}} \geq d_v \qquad (8.98)$$

Stud spacing

Tangential spacing rules are stricter in Gen 2. In Gen 1, the first perimeter allowed spacing up to 1.5d; Gen 2 reduces this to 0.75d, with subsequent perimeters limited to 1.5d. [22]

	Tangential spacing of shear reinforcement	
Gen 1	At a distance ≤ 2d from column face, $s_{t,max} = 1.5d$ At a distance > 2d from column face, $s_{t,max} = 2d$	**9.4.3 Punching shear reinforcement** The spacing of link legs around a perimeter should not exceed 1.5d within the first control perimeter (2d from loaded area), and should not exceed 2d for perimeters outside the first control perimeter where that part of the perimeter is assumed to contribute to the shear capacity (see Figure 6.22).
Gen 2	First perimeter of studs, $s_{t,max} = 0.75d_v$ At a distance ≤ $2d_v$ from column face, $s_{t,max} = 1.5d_v$ At a distance > $2d_v$ from column face, $s_{t,max} = 3d_{v,out}$	**12.5.1 Punching shear reinforcement** The tangential spacing of shear reinforcement should be limited based on the distance to the column edge (see Figure 12.7 c). For shear reinforcement located at a distance ≤ $2d_v$ from the column edge, the tangential spacing should not exceed $1.5d_v$ and it should not exceed $0.75d_v$ and $0.5d_v$ for flat slabs and column bases, respectively, in the first perimeter. The tangential spacing of shear reinforcement should also meet the requirements of Figure 8.24.

Key Changes relevant to punching shear

Studs vs. Links

Gen 2 introduces a new parameter ($d_{v,out}$) which is maximised through use of shear studs compared to links or stirrups. [22]

This, in turn, allows for more favourable calculations when double-headed shear studs are used: of the design shear stress at outer perimeters, of the length required for the outer control perimeter, of the minimum distance between the outermost shear perimeter and the outer control perimeter, and of the tangential spacing between studs.

The maximum permissible punching shear resistance for a reinforcement layout is also greater when studs are used. [22]

$$\tau_{Rd,max} = \eta_{sys} \cdot \tau_{Rd,c} \quad (8.109)$$

$$\eta_{sys} = 0.70 + 0.63\left(\frac{b_o}{d_v}\right)^{1/4} \geq 1.0 \text{ for studs} \quad (8.110)$$

$$\eta_{sys} = 0.50 + 0.63\left(\frac{b_o}{d_v}\right)^{1/4} \geq 1.0 \text{ for links and stirrups} \quad (8.111)$$

The current draft of the UK National Annex defines the η_{sys} values as on the right. The correct values to be used in the UK will be confirmed when the NA is published. These values are likely to vary between different Europeans countries and some countries may adhere to the Eurocode recommended values in the above equations (8.110) and (8.111).

$$\eta_{sys} = 0.77 + 0.69\left(\frac{b_o}{d_v}\right)^{1/4} \geq 1.0 \text{ for studs}$$

$$\eta_{sys} = 0.55 + 0.69\left(\frac{b_o}{d_v}\right)^{1/4} \geq 1.0 \text{ for links and stirrups}$$

Control perimeter location

Location of the control perimeter:

Gen 1: u_1 @ 2d from column face [17]

Gen 2: $b_{0,5}$ @ $0.5d_v$ from column face [22]

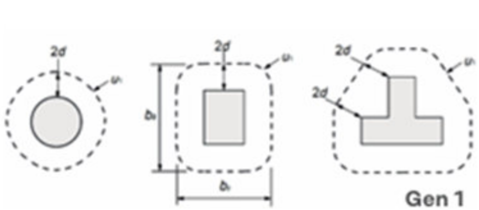

Figure 6.13: Typical basic control perimeter around loaded area

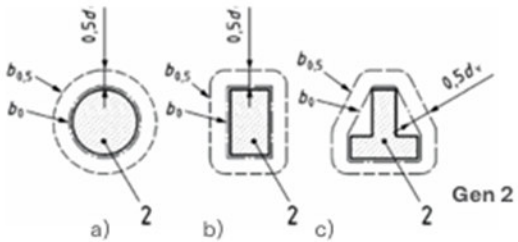

Figure 8.18: Typical control perimeters $b_{0.5}$ and b_0 around supporting areas (same perimeter shapes)

The location of the control perimeter set in Gen 2 more realistically models a potential punching failure. This was one of the goals achieved by the Eurocode 2 revision.

Upcoming trends and considerations

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BIM-enabled reinforcement modelling

The next step is the direct export of reinforcement layouts from design tools into BIM models. For stud rails, this means each slab–column connection could be represented in the model as an intelligent object, reducing manual transfer errors and improving coordination.

AI-assisted and generative design

Advances in artificial intelligence and generative design are shifting practice from verification towards optimisation. Early workflows already demonstrate how BIM–AI pipelines can propose reinforcement layouts that balance safety, constructability, and material efficiency. These developments will not replace engineering judgement, but they will provide powerful tools to guide engineers towards safer and more sustainable outcomes.[15]

Data interoperability and collaboration

Ensuring that reinforcement data carries not just geometry but also meaning is increasingly important. Techniques such as semantic enrichment help preserve metadata across platforms, while cloud-based collaboration platforms enable teams to co-author models in real time, keeping reinforcement aligned with the wider structure.[16]

Wider industry context

Beyond reinforcement, BIM itself is evolving. Digital twins, sustainability-linked modelling, and 5D BIM (integrating time and cost) are becoming mainstream, while regulatory drivers in many countries are accelerating adoption. These broader developments create an environment where reinforcement tools are expected not just to calculate, but to connect seamlessly with project data.[15,16]

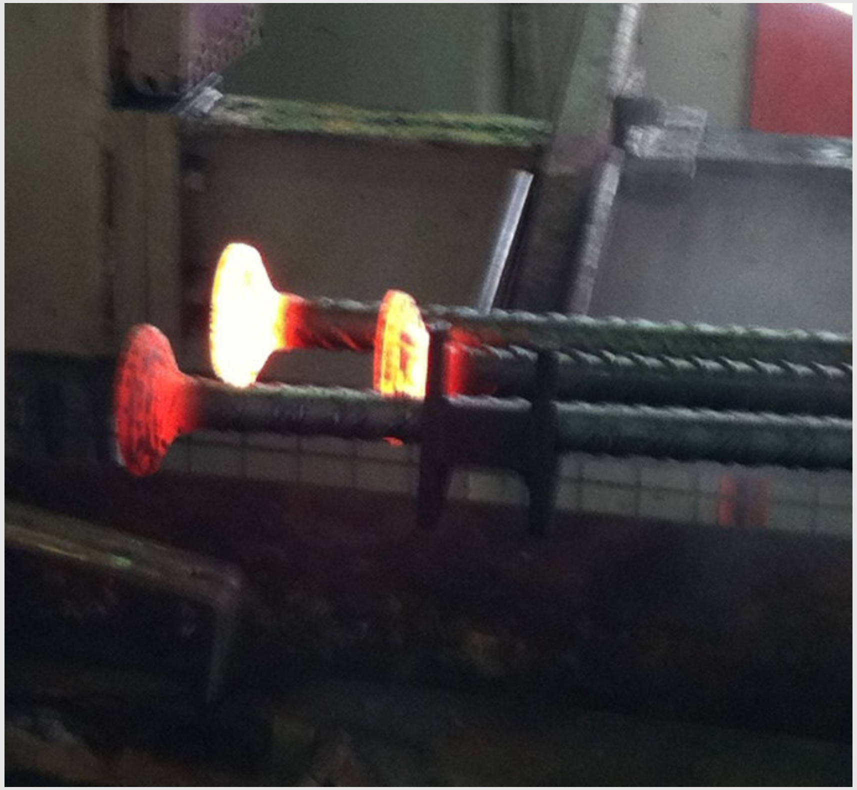
Looking ahead

Adoption remains uneven across regions and contractors, but the trajectory is clear. Engineers and clients are seeking digital tools that deliver clarity, integration, and confidence. With the transition to the second generation of Eurocode 2, reinforcement design will also enter a new phase.

National annexes have not yet been published, but once they are confirmed, software updates can follow to support consistent adoption across markets. Leviat is closely monitoring these changes and will update its tools once requirements are confirmed, ensuring that users can adopt the new standards with confidence.

Product and Applications

Basics:



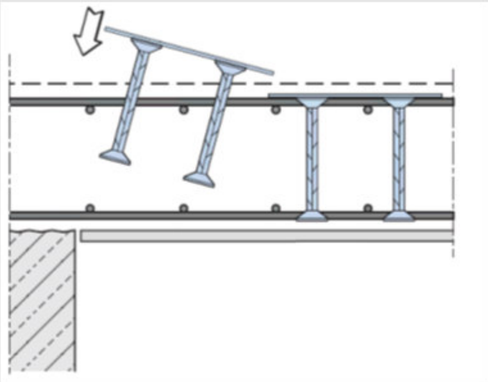
Forged heads (3xD) Material: Grade 500 Rebar

Product and Applications

Installation Methods

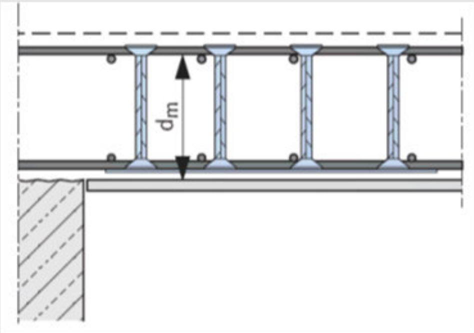
HDB – Standard Elements

- Recommended for slab thickness up to 350cmm
- Rails with 2 or 3 studs
- For standard slabs
- Installation from Top (or Bottom)



HDB – SK Elements

- Recommended for slab thickness **above** 350mm
- Rails from 2 up to 10 studs
- For stadard slabs as well as foundations
- Installation from Bottom (or Top)



Product and Applications

Installation from the Top

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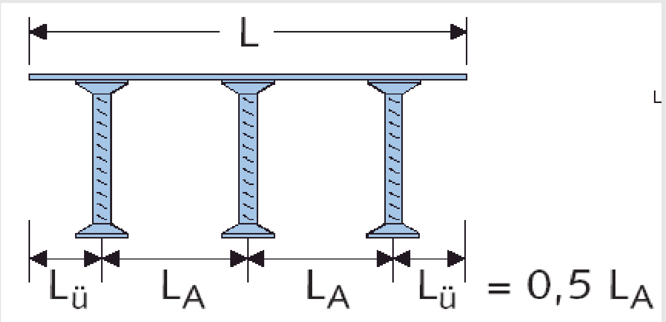
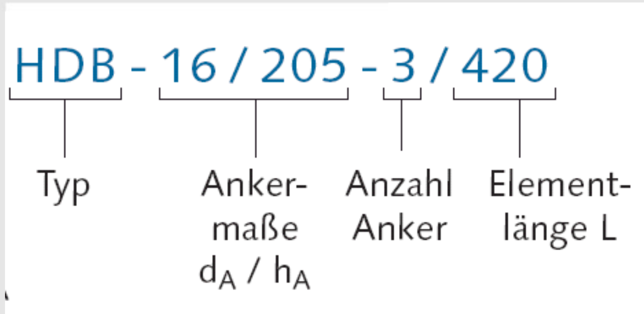
Product and Applications

Installation from the Top – Standard Elements

- Rails with 2 or 3 studs
- Can be quewed up
- Available stud Ø
  10, 12, 14, 16, 20, 25 mm
- Standardised range
  (available from stock)

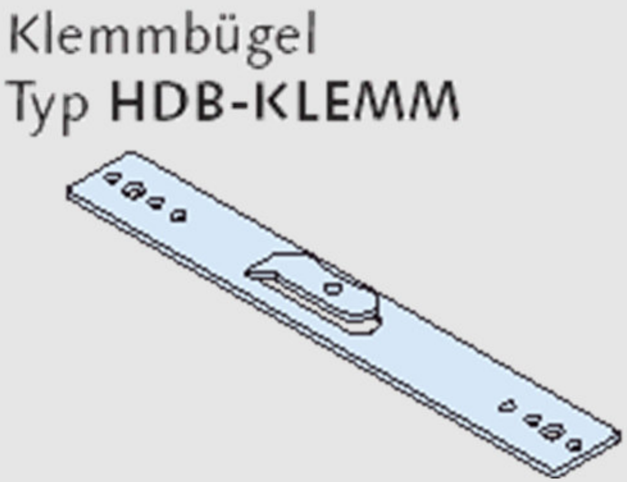


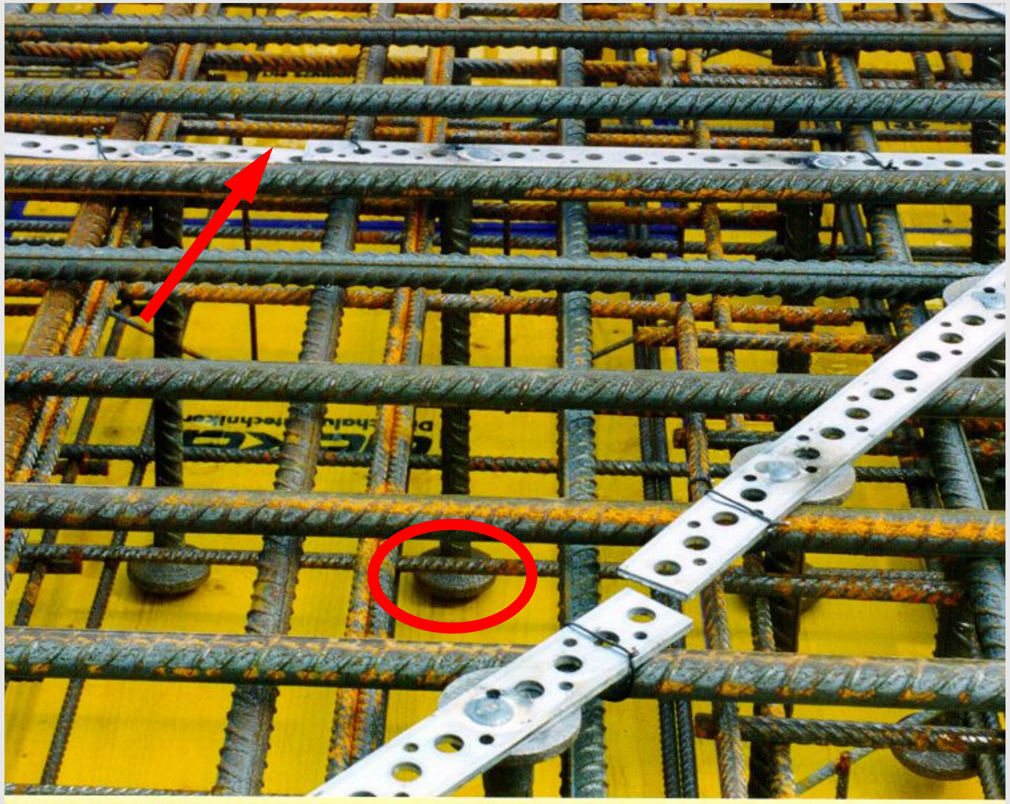


Product and Applications

Installation from the Top – Accessories

Klemmbügel





Product and Applications

Installation from the Bottom

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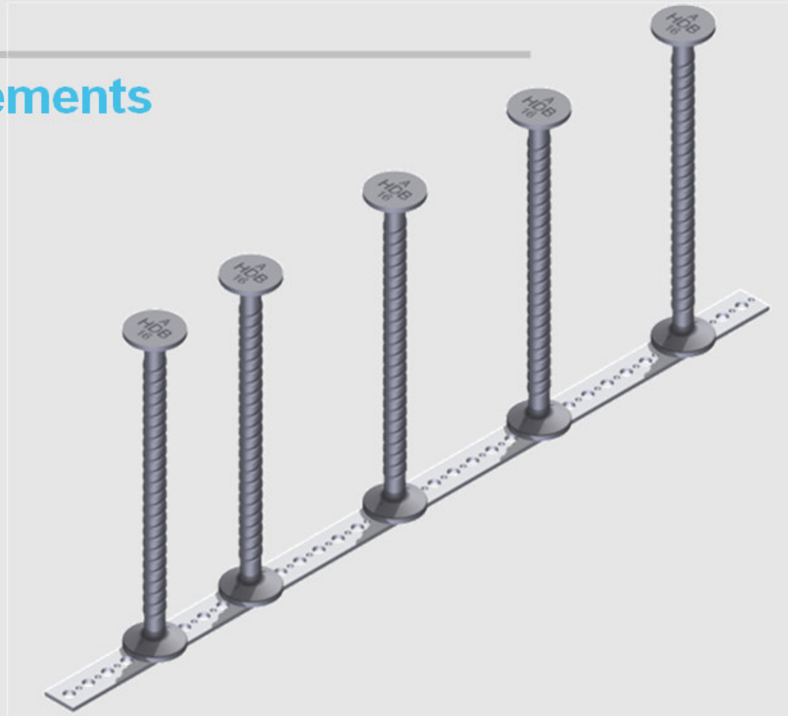
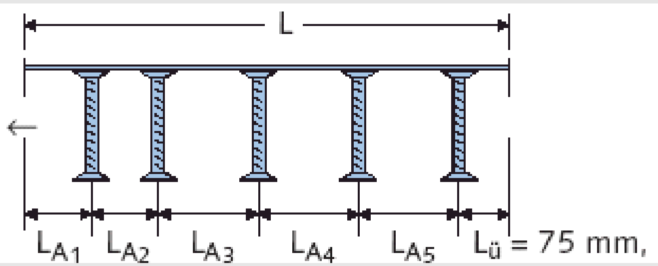
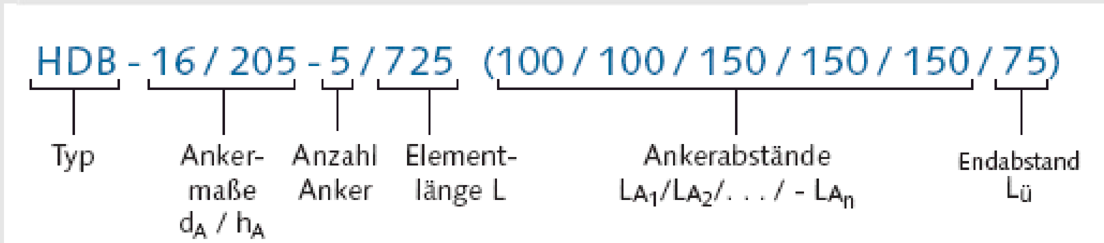
Product and Applications

Installation from the Bottom – SK Elements

- Rails up to 10 studs
- Available stud Ø
  (10), 12, 14, 16, 20, 25 mm
- Bespoke production on demand
  (single studs might be on stock)





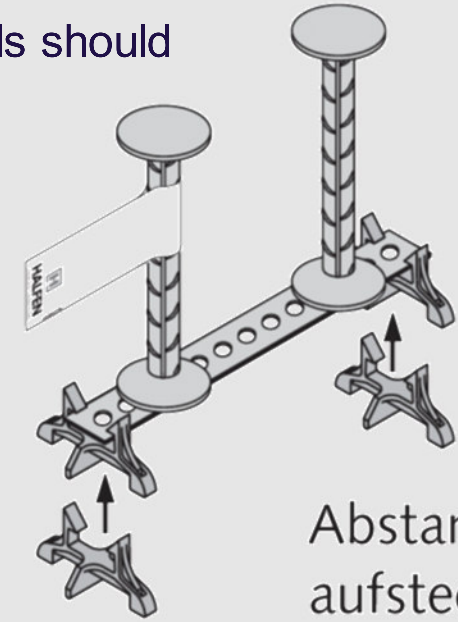


Product and Applications

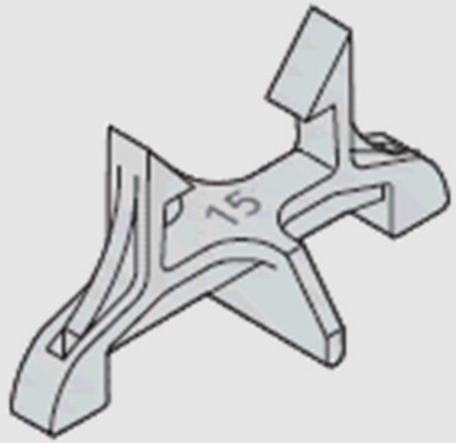
Installation from Bottom – Accessories

Spacer

- Spacer is marked with concrete coverage c_{nom}
- Spacer consists of nailholes
- When using a steel shuttering the rails should be fixed to the lower reinforcement.



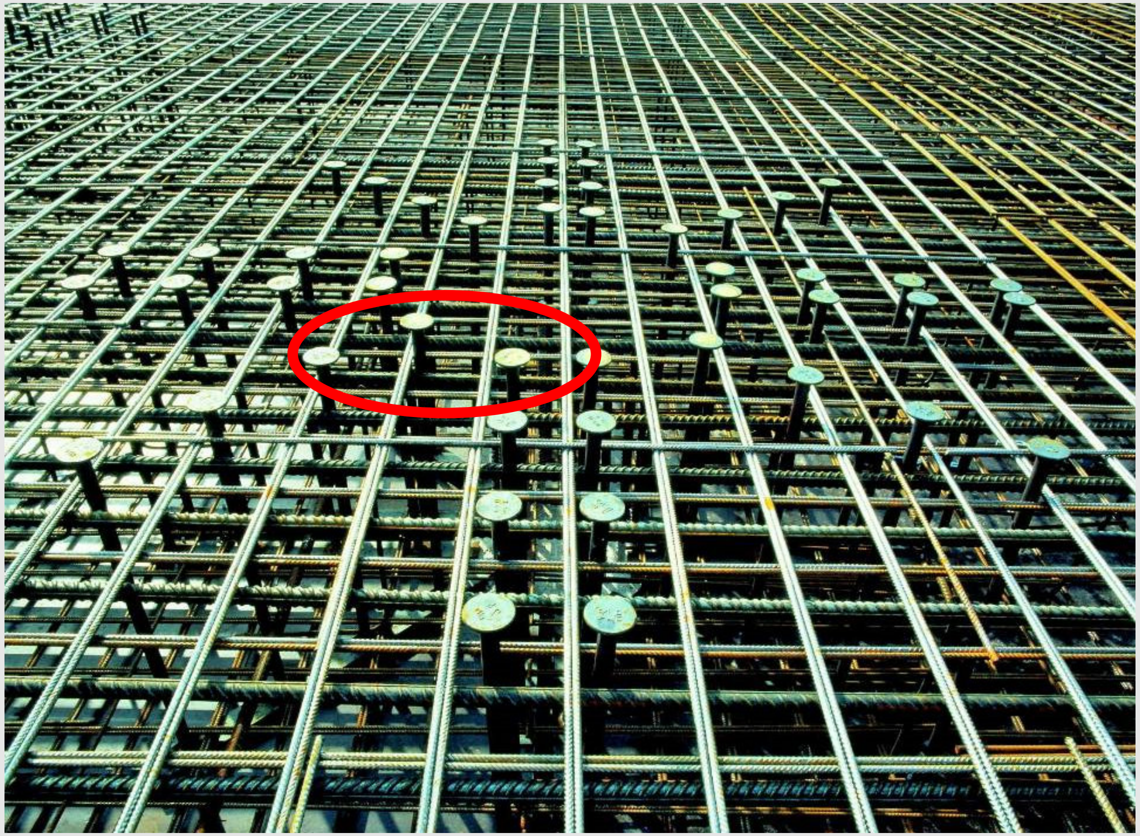
Abstandhalter aufstecken



Abstandhalter **Typ HDB ABST**

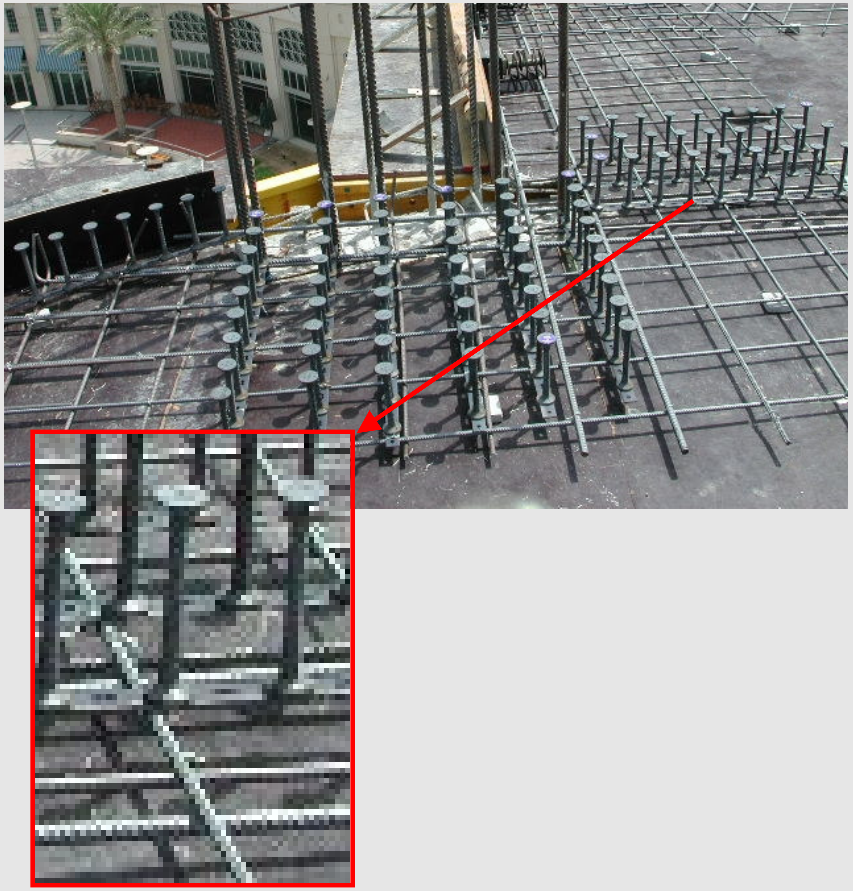
Product and Applications

Installation from Bottom – Incorrect istallation



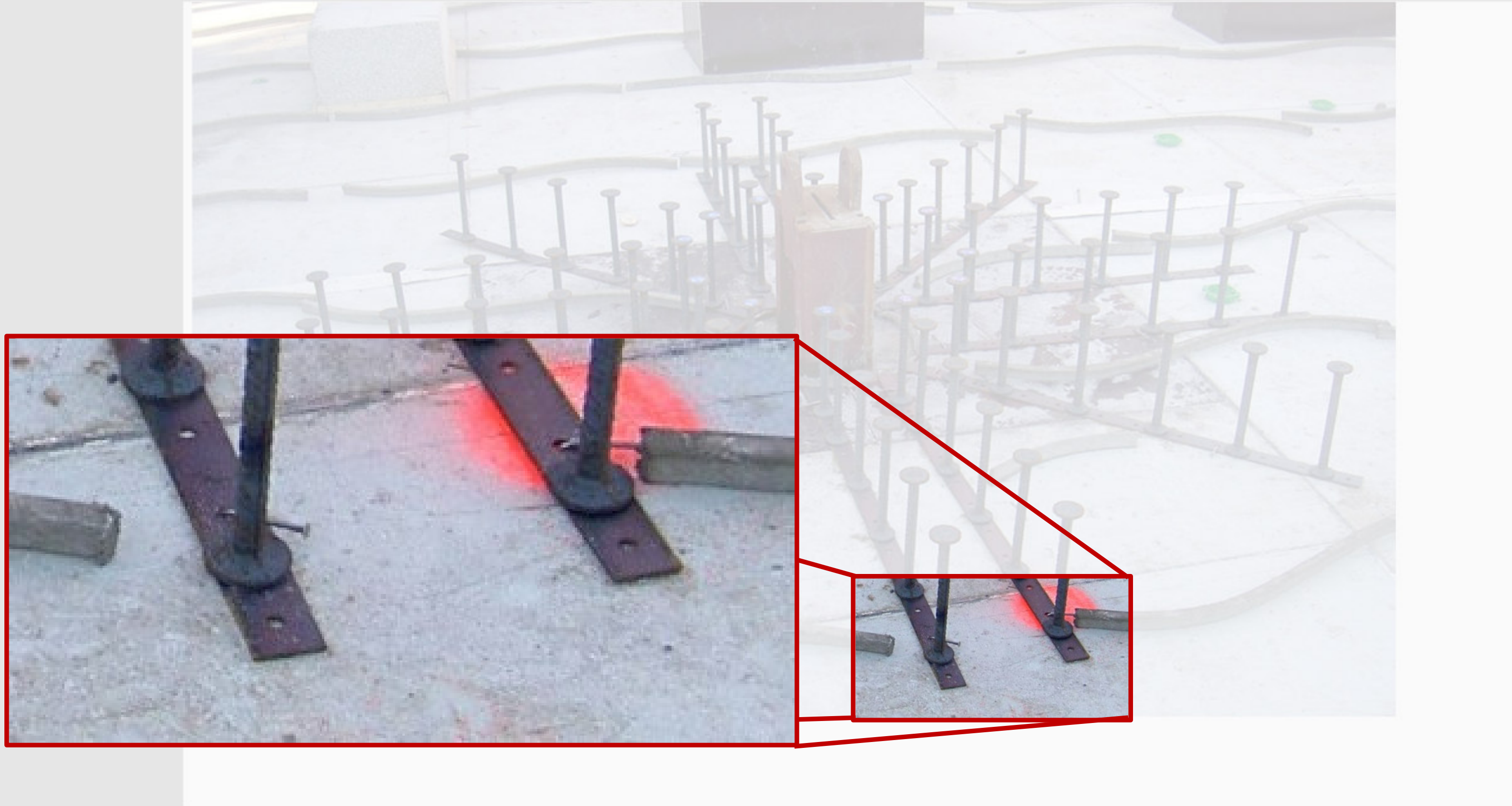
Product and Applications

Installation from Bottom – Incorrect istallation



Product and Applications

Installation from Bottom – Incorrect istallation



2. Applications

1. Installation in cast in situ concrete slabs

Drukarina, Switzerland

2. Applications

1. Installation in cast in situ concrete slabs

Manhattan, Switzerland

2. Applications

1. Installation in cast in situ concrete slabs

Prisma, Germany

2. Applications

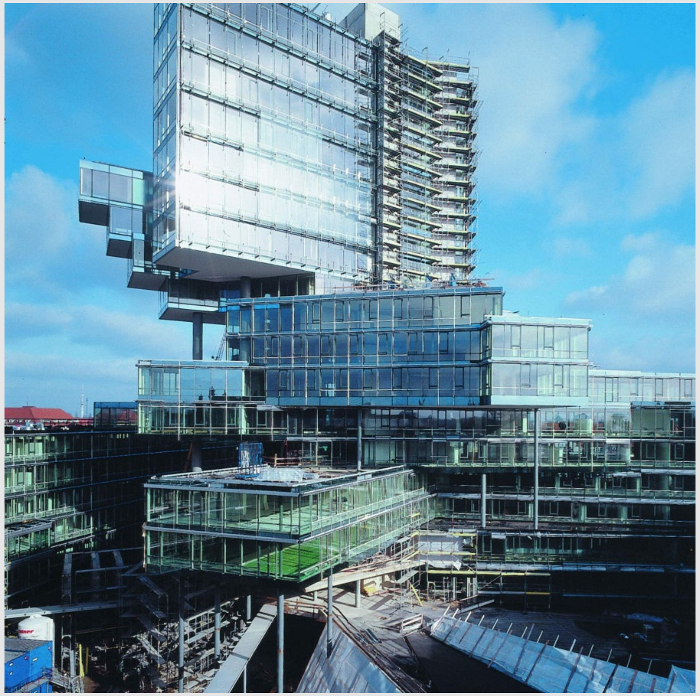
1. **Installation in cast in situ concrete slabs**

Main Tower, Germany

2. Applications

1. Installation in cast in situ concrete slabs

Nord LB, Germany



Punching Shear Reinforcement for Foundations

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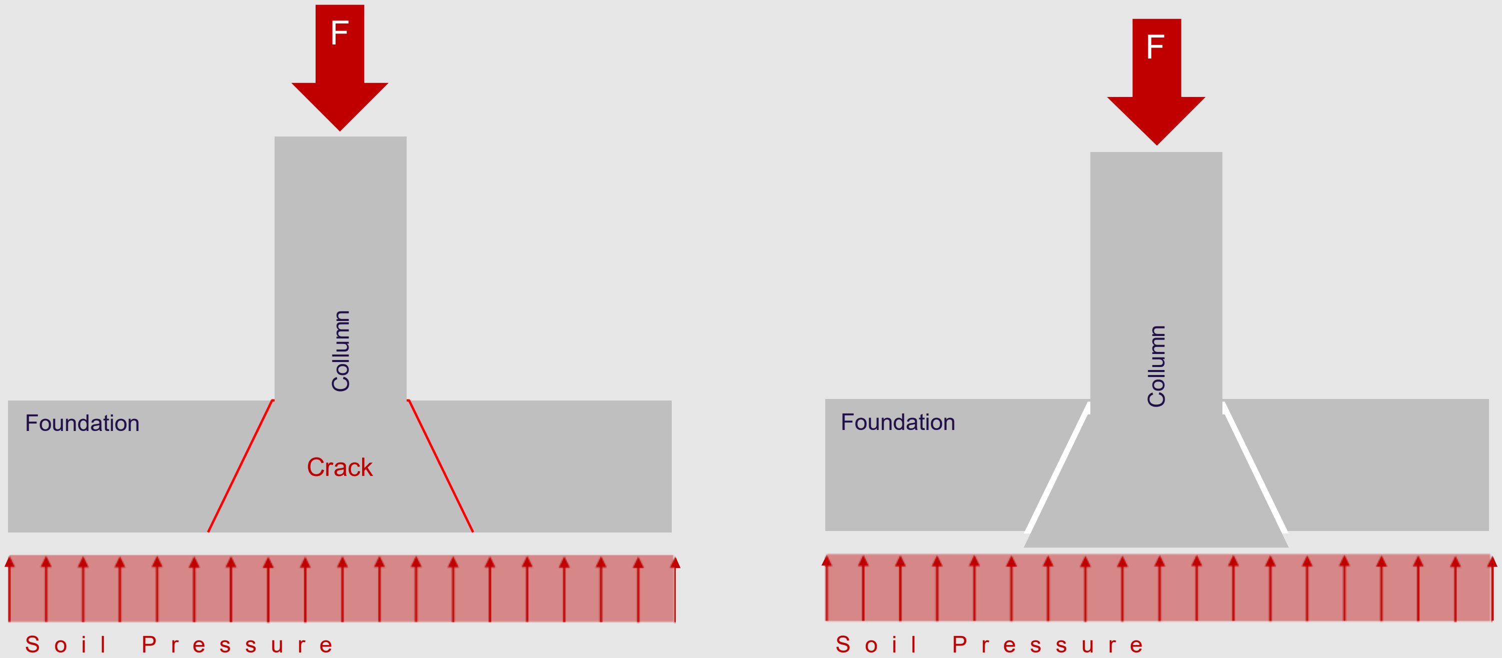

- High local loads comes from column to foundation
- Concrete failure to come once concrete resistance is overloaded
- Faliure related to punching shear faliure at slabs

→ Additional reinforcement is needed to avoid punchig shear faliure

Punching Shear Reinforcement for Foundations

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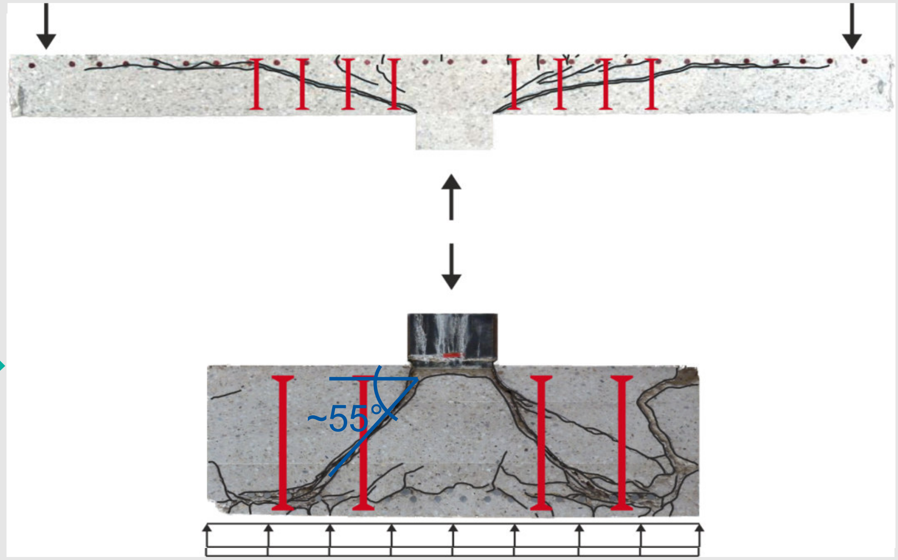
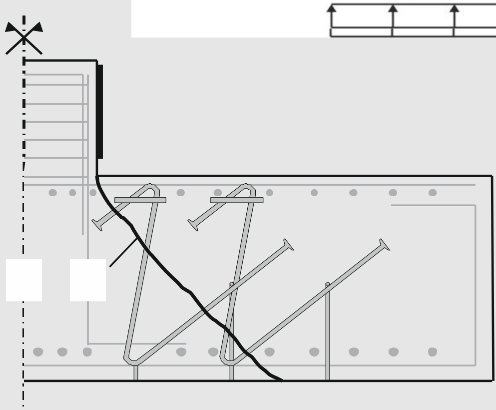
- Solution: HDB-Z





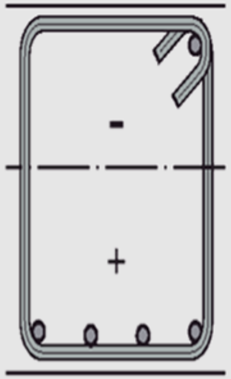
- Standard slabs: Cracking cone at around 35°: Double headed studs are effective
- Foundations: Cracking cone ar around 55 -65° Vertical reinforcement is not effective.

-> Goal was to develope a new system for effective crack stitching.

Punching Shear Reinforcement for Foundations

Available systems

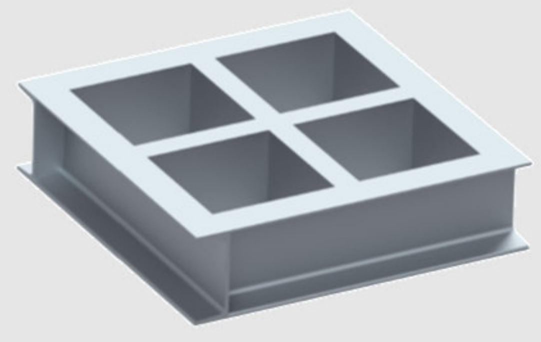
Rebar stirrups

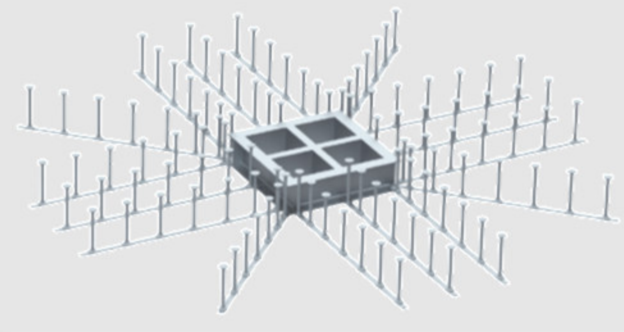


Double headed studs:
HDB Studrails

HDB-Z „Swan“

DURA Steelhead





Punching Shear Reinforcement for Foundations

Performance comparison

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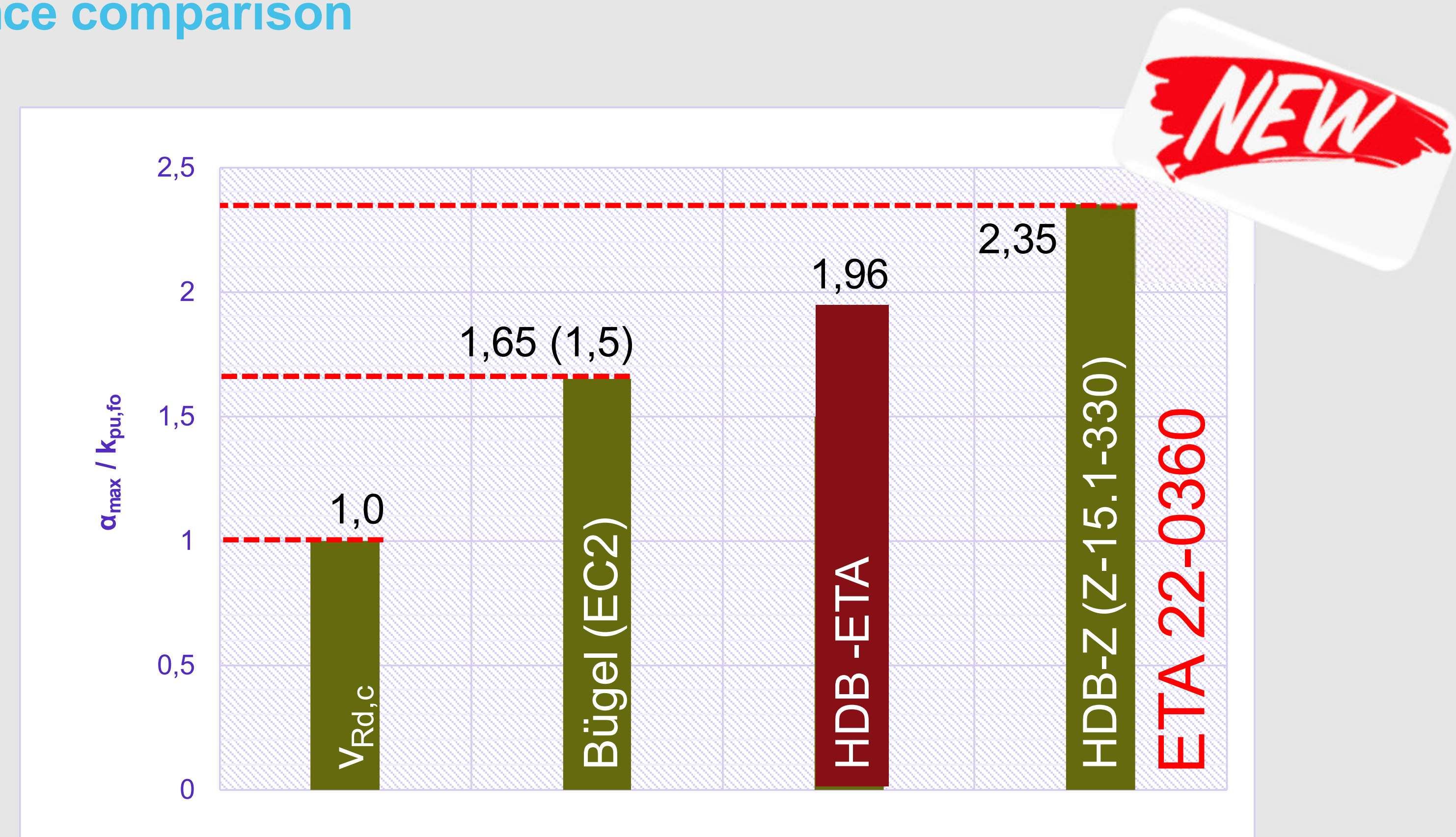
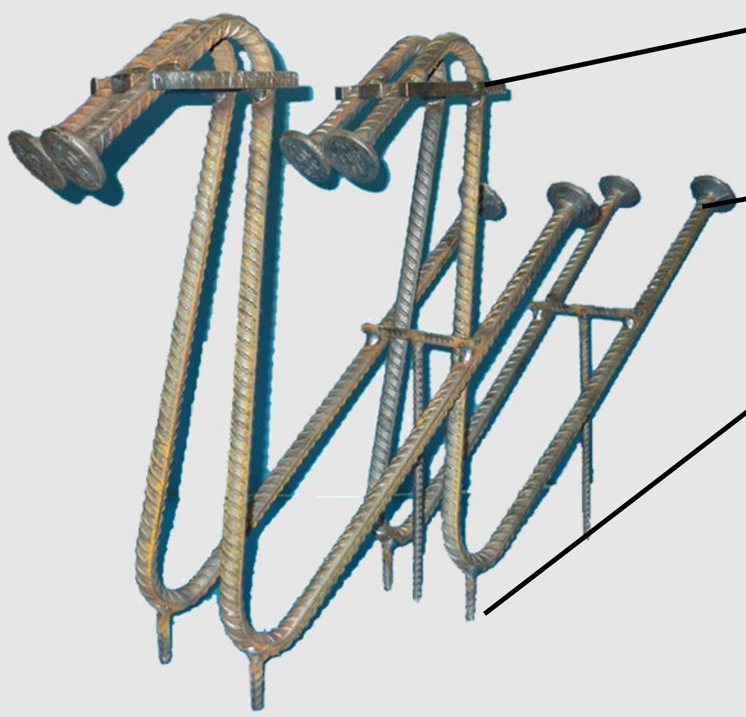


Punching Shear Reinforcement for Foundations

HDB-Z

Elements queued

Element No.1	Element No.2

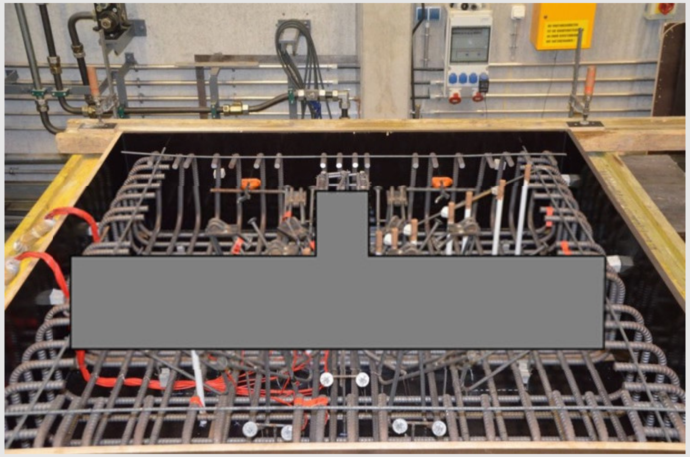


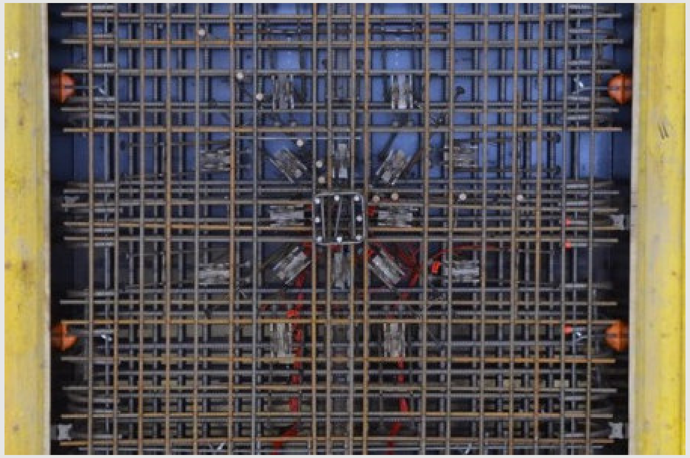
Steelplate
(S235 nach DIN EN 10025-2)

„Z-shaped“ HDB Studs
(B500B acc. to DIN EN 1992-1-1, Annex C)

Spacer

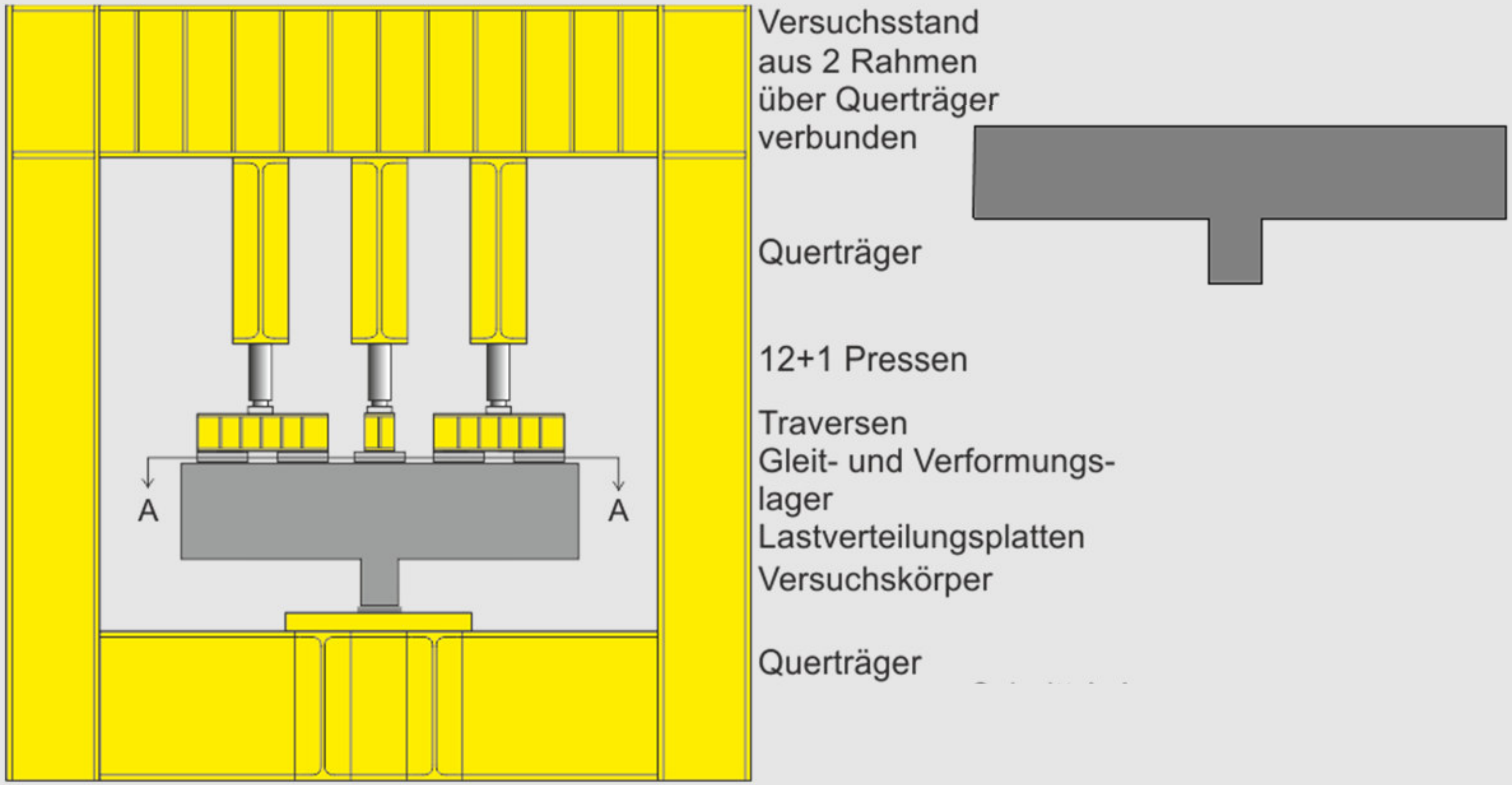
HDB-Z





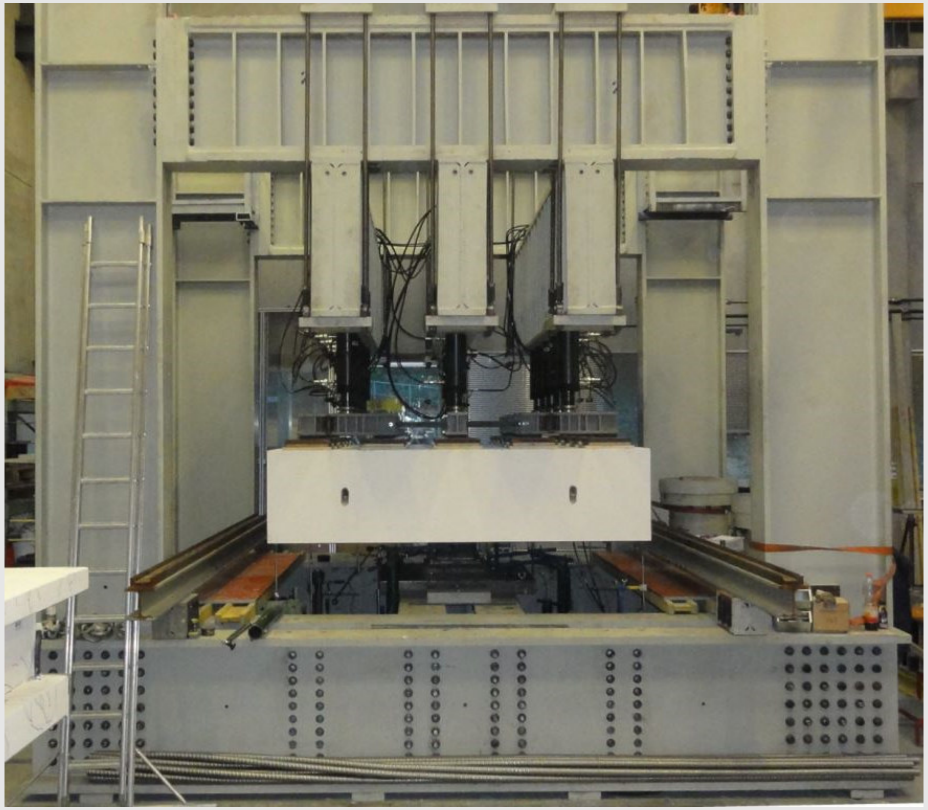
HDB-Z

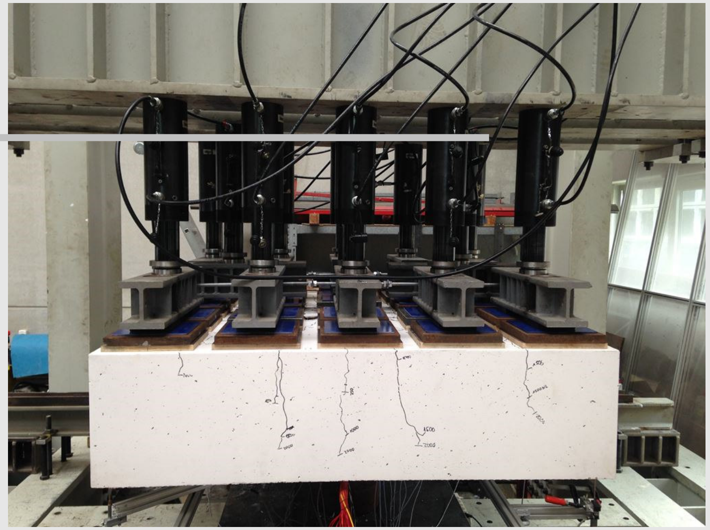
Testing

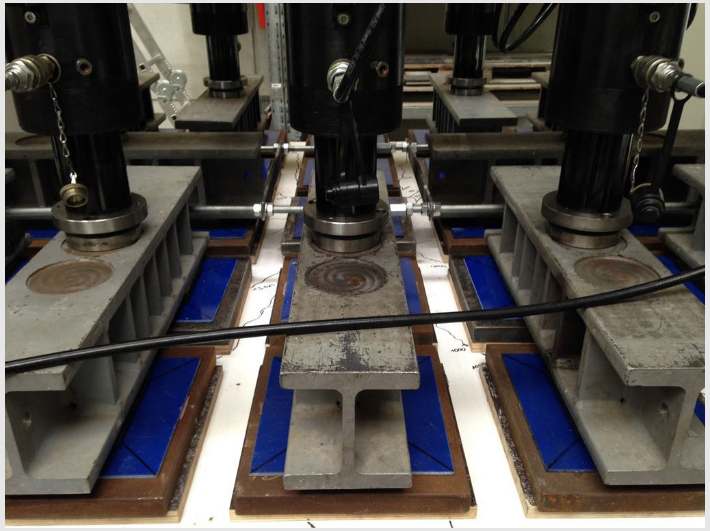


HDB-Z

Testing







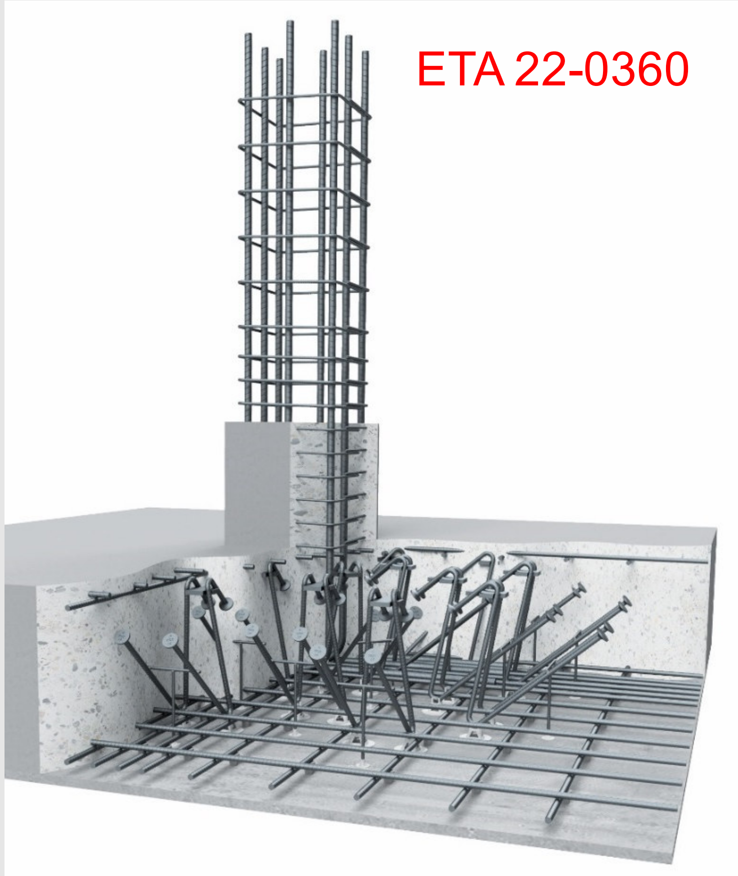
HDB-Z Punching Shear Elements

Approval

- German Approval (abZ) from DIBt
- European technical Assessment ETA 22-0360
- Designconcept according to EC2 for foundation slabs and single foundations.

Scope of application:

- Punching shear reinforcement for predominantly static load requirements as well as for fatigue loads. Fatigue range of stress $\Delta\sigma_{Rsk}$ = 70 N/mm² at n ≤ $2x10^6$ cycles.
- Concrete strength for foundations: C12/15 up to C50/60.
- Foundation thickness: h ≥ 230mm.
- Reasonable performance advantage < 1200mm



HDB-Z Punching Shear Elements

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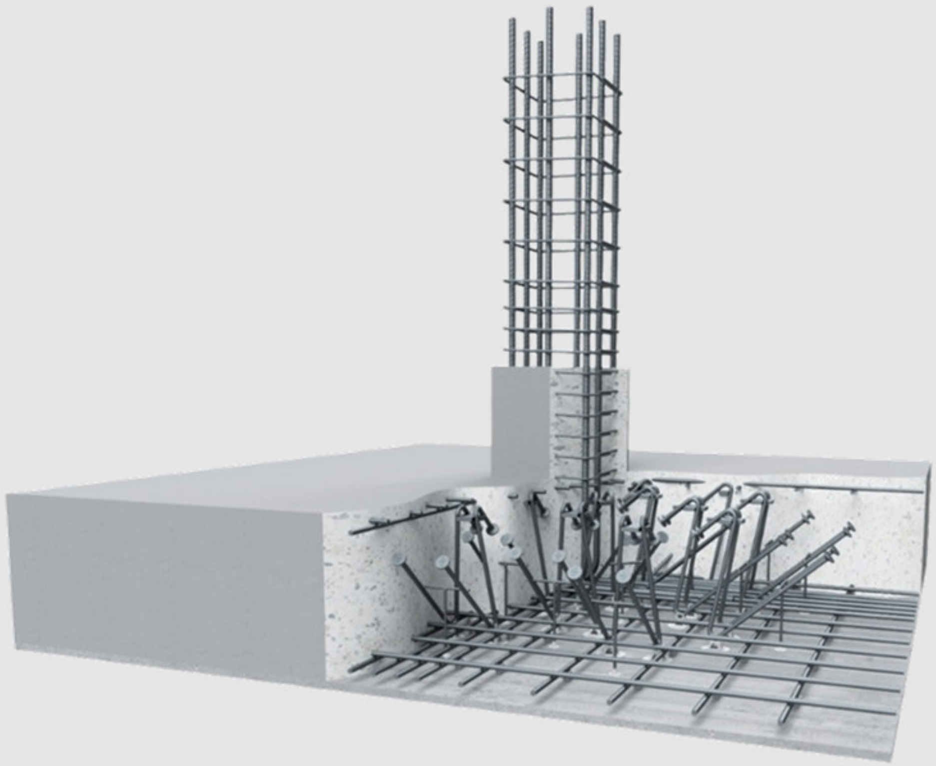
HDB-Z

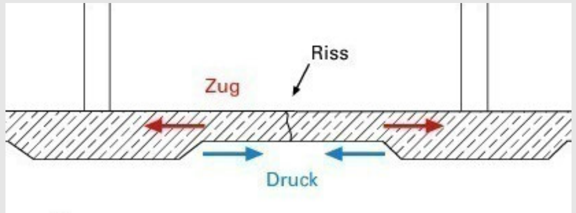
For foundation / ground slabs

Advantages:

- High punching shear restistance
- Patent and German approval available + ETA
- Reduced the foundation thickness up to 40%!
- Avoid concrete haunches at foundation
- Less concrete,- excavations, - water
- Saves time, energy and money in specific situations.
- Calculation Software available.



Foundation Haunches



Foundation Haunches

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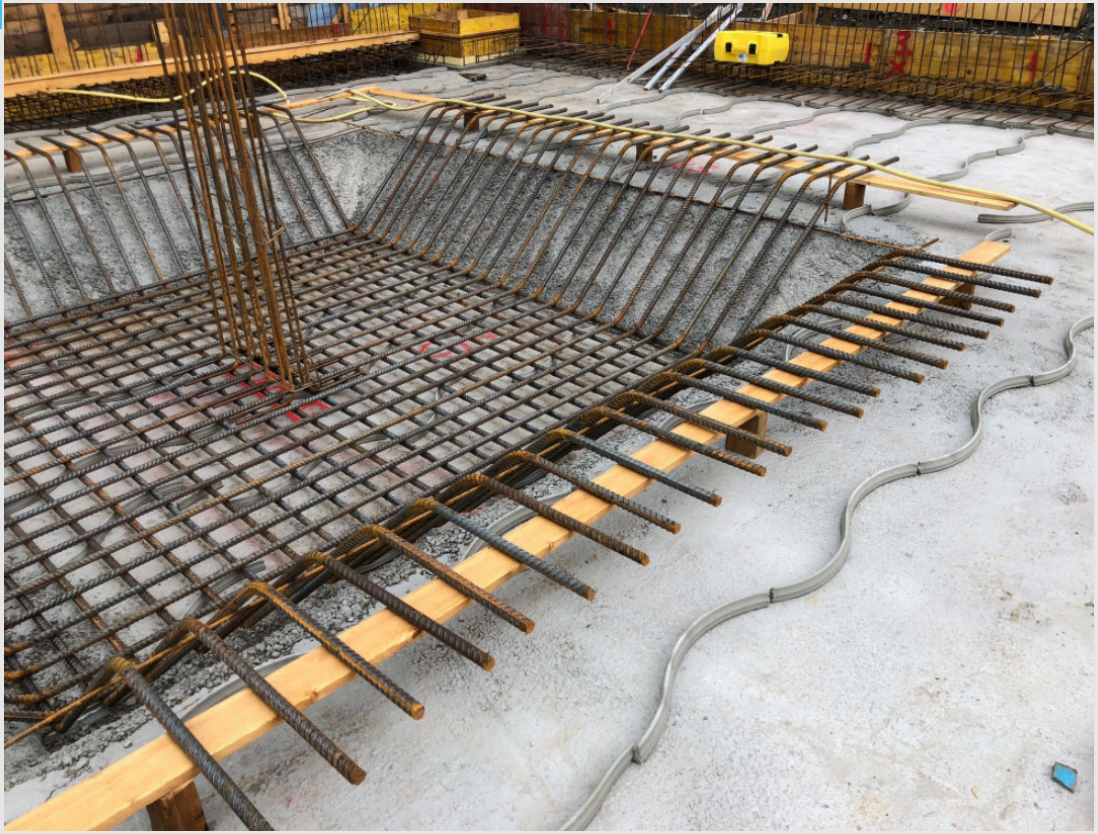

Dropping the groundwater level

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Dropping the groundwater level

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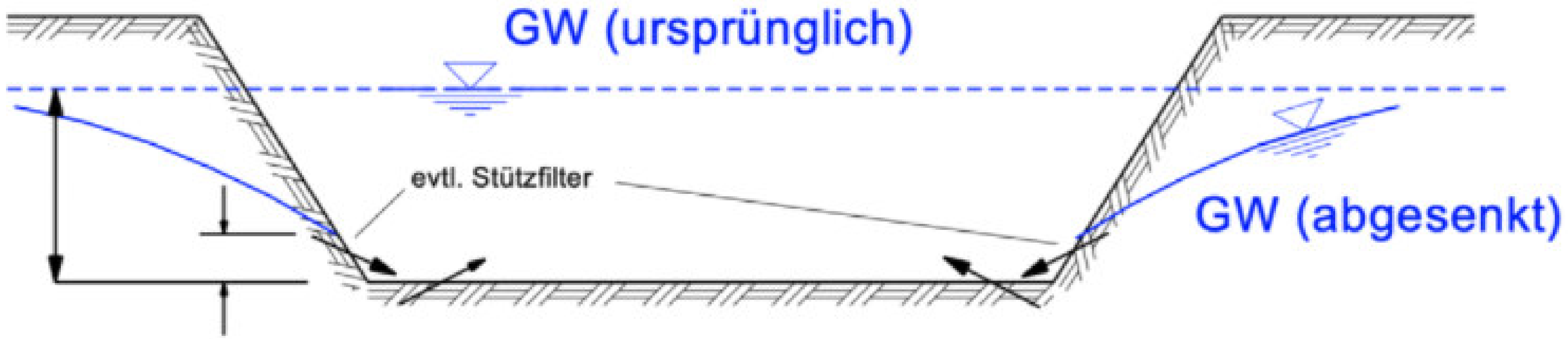
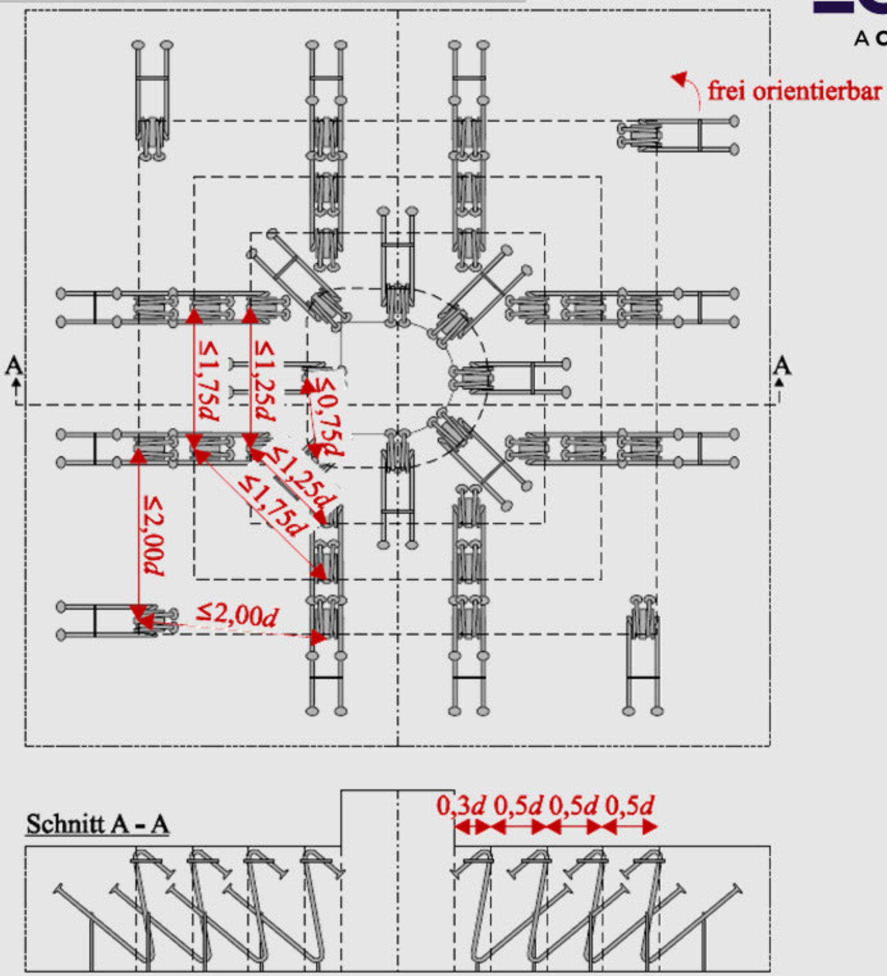


HDB-Z Punching Shear Elements

Installation

- Installation suitable for circle and square shaped columns
- No. of elements in 1st row $N_{1\ \&\ 2} \geq 8$ depending on distance.
- 1st row: Distance from column s_r = 0,3d.
- Remaining rows keep a distance of s_r = 0,5d from the elements in previous row.



HDB-Z Punching Shear Elements

Project Hotel in Cologne

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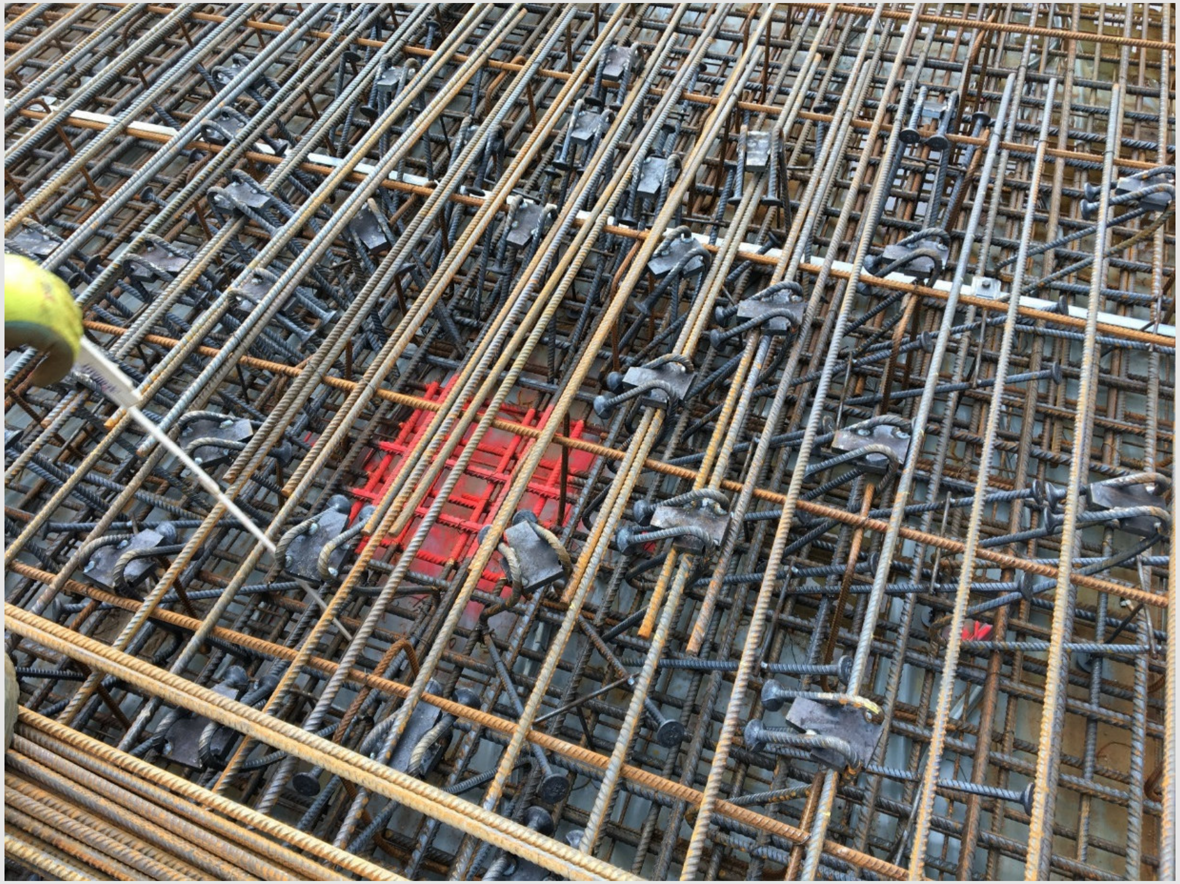

HDB-Z Punching Shear Elements

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Project Berlin High rise building

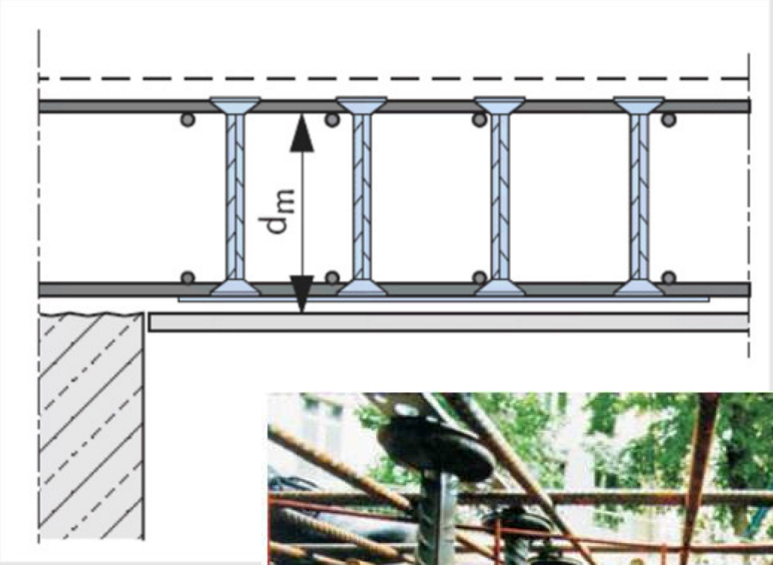
Summary

HDB Studrails

For standard slabs

Advantages:

- Easy and fast to install from top and bottom.
- ETA approval
- Performance up to 20-30% in comparison to standard reinforcement.
- Well known on the market
- Calculation Software



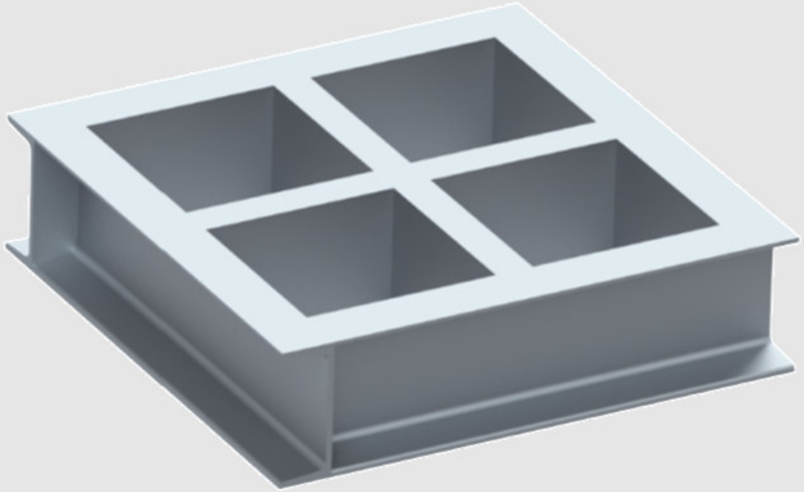
Summary

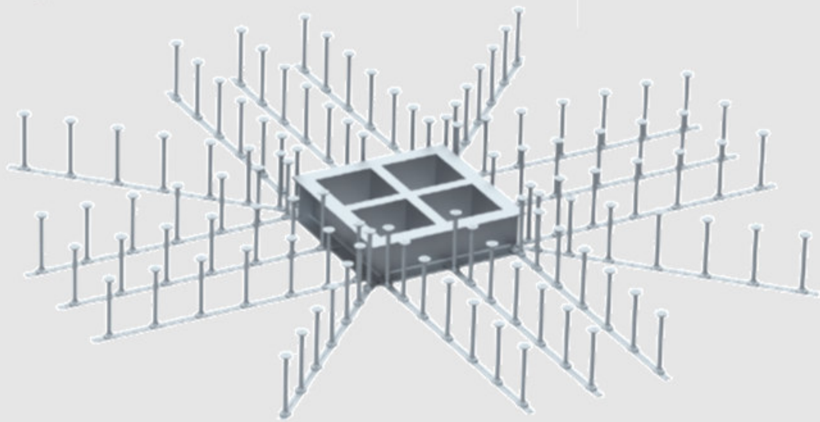
DURA Steelhead

For standard slabs

Advantages:

- Very high performance especially on small columns.
- Calculation Software based on Eurocode and SIA
- Applied for DiBt approval in Germany





HDB-Z Punching Shear Elements

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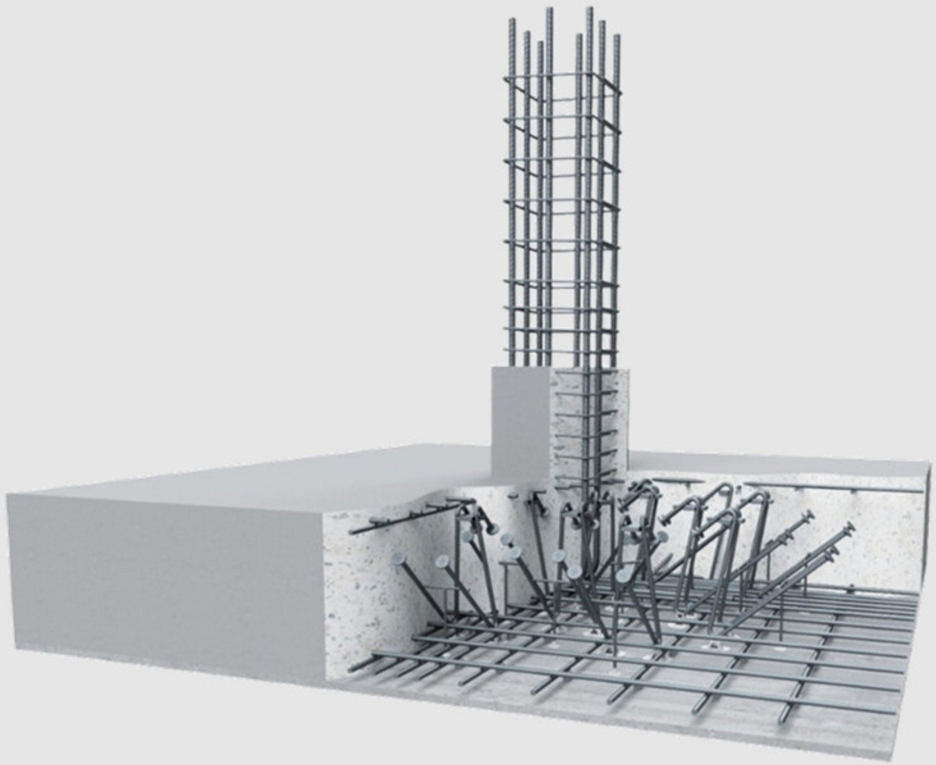
HDB-Z

For foundation / ground slabs

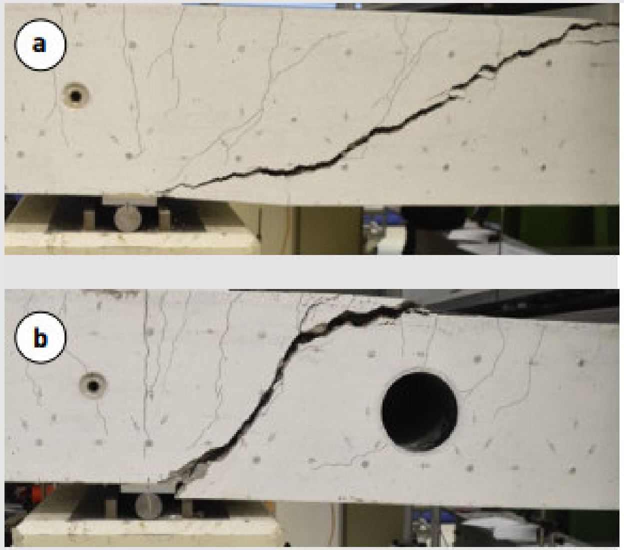
Advantages:

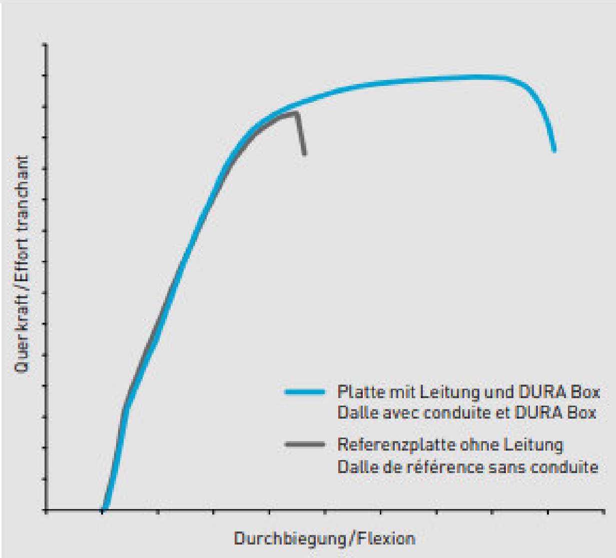
- High punching shear restistance
- Patent and German approval available + ETA
- Reduced the foundation thickness up to 40%!
- Avoid concrete haunches at foundation
- Less concrete,- excavations, - water
- Saves time, energy and money in specific situations.
- Calculation Software available.



Aschwanden DURA Box: German DiBt approval available

- DURA Box is used to reinforce the ‘predetermined breaking areas’ in concrete slabs generated by the inclusion of large pipes and tubes
- The system avoids cracks going through the voids in the slab





Grazie!

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Imagine. Model. Make.